ADHESIVES AGE

MANUFACTURE, APPLICATION, TECHNOLOGY, RESEARCH AND MARKETING OF ADHESIVES

IN THIS ISSUE

Postage Stamps That Stick

Nomenclature for the Adhesives Industry

NOVEMBER, 1958

COMING SOON

The editors of ADHESIVES AGE have selected a great variety of articles for publication in future issues in order to provide the widest possible coverage of the vast adhesives industry. Watch for these articles scheduled to appear shortly.

- **The British adhesives industry—manufacture and application**
- **How to dry mix basic resin adhesives**
- **Uses of epoxies and silicones in adhesives**
- **Rheology and electrokinetics of adhesives**
- **Tackiness of liquid adhesives during roll application**
- **Production problems minimized for adhesive container labeling**
- **Defoaming agents for the automatic application of animal glue**
- **A new process for constructing integral wing fuel tanks**
- **How the government uses adhesives**
- **Resin adhesives for palletizing operations**
- **Bindery adhesives find wide use at United Nations**
- **Adhesives for the food processing industry**
- **Animal glues find use in uranium reclamation**
- **Resin adhesive development and mixing**

These and many other interesting articles will soon be in print

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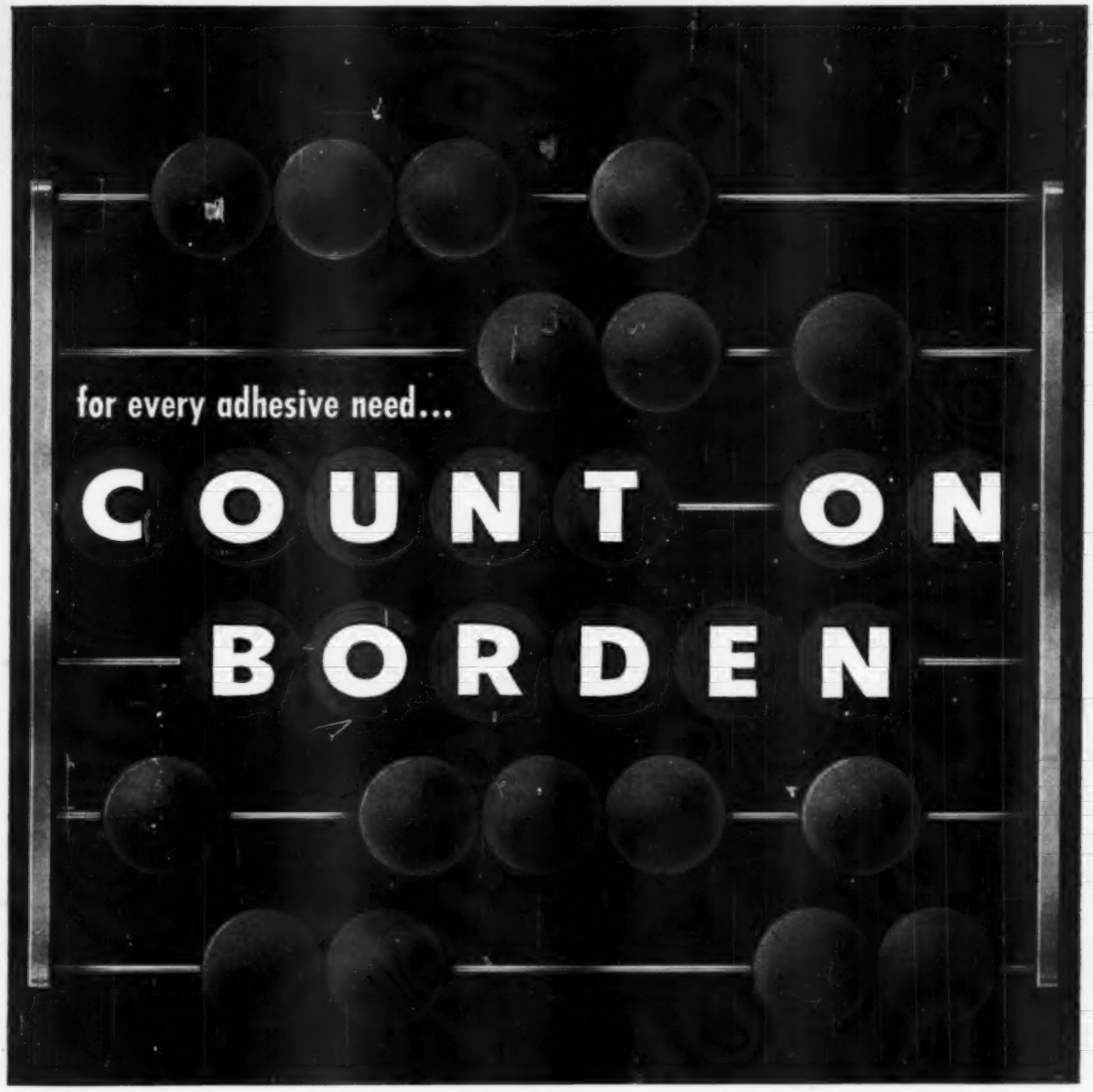

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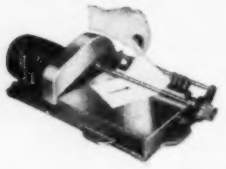

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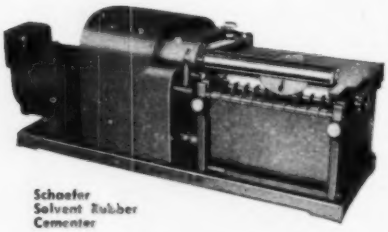

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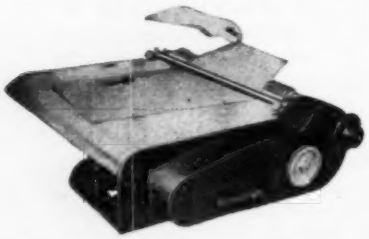

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EDITORIAL

We are living in a polymer age. Now that's an empty statement if ever one was made. Many centuries ago polymers were used, but they weren't called that. They were called "glue" or "starch" or "rubber" or any number of other specific things.

The only conclusion is that if a modern polymer has a special quality, it is no grounds for amazement. It is true that some of the "newer" polymers, like resins, vinyls, man-made rubber, and inorganic adhesives, are understood a bit better, but this is only true because they were made from basic materials by man. The day is fast approaching when man will have a clear understanding of the molecules which make up the "old" polymers.

Slowly, our concepts of adhesive bonds have begun to take new definition. This has been true since the beginning of the century; since those days when, emerging from a vague and somewhat confused concept of the nature of the chemical bond, Linus Pauling wrote his famous work of that name. The whole picture of the forces which hold together and govern chemical molecules has become clearer despite the many men who do not see eye to eye with Pauling. Within the last twenty years we have begun to see new approaches to our concepts of the adhesive bond. All our knowledge is intertwined.

In the matter of adhesive bonds most people are rather vague. A rather puerile approach, but one which carries strength goes like this: Have you ever seen an animal held together with nuts and bolts? Have you ever seen a tree that was welded together? In the last analysis, all nature, including human beings, is held together with adhesive bonds. We can't expect to reproduce similar bonds immediately, nor can we expect to approach them in the next few years. However, maybe it will help our understanding, both of adhesives and of nature, if we bear in mind that there is a basic relationship between the nature of the bond that holds molecules together and the forces exerted by an adhesive which holds materials together.

One of the reasons why a science serves is that it creates method out of chaotic disunity. This is one of the principal roles of science. Still, by itself science cannot propagate its findings. The greatest scientist that ever lived would be by-passed and his work of no value if he were unable to pass his knowledge on to other men.

ADHESIVES AGE exists to help the sciences to propagate and discuss the new approaches, techniques and principles which are devised and discovered from time to time. It is here in these pages that a new forum exists; a place where all interested men may meet and exchange ideas. From ideation we move to creation and thence to production.

Arch Doria

EDITOR

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CONSULTANT'S CORNER

By Dr. Irving Skeist

Epoxy Resin Adhesives – I

The epoxy adhesives have taken hold. In a few short years, they have established themselves in a thousand applications for bonding metals, glass, ceramics, polyesters, phenolics and other materials. The versatile epoxies may be compounded with a variety of other materials, with or without filler, sometimes on glass tape, often alloyed with polyamide, polysulfide rubber or phenol-formaldehyde resin.

The aircraft industry has developed a special fondness for the epoxies. To a significant extent, they are replacing rivets and spot welding for the bonding of metal to metal. They bond aluminum sheet to itself or to other metals, permit the construction of thin-skinned honeycomb sandwiches of high flexural strength, are tougher than metal solders for joining parts. Under repeated cycling at low stress, the epoxy glue line often outlasts the metal adherends. Fiberglass-reinforced polyester fuel tanks are made in sections and then sealed together to give a stronger weld than is obtainable from the polyesters themselves.

In the electronics and other small-parts-assembly industries, epoxies are performing notably for the bonding of copper to phenolics in printed circuits, for attaching small parts, for embedment and encapsulation of delicate metal parts.

Resinous adhesives offer several advantages over metal fasteners for metal-to-metal bonding. The stress is distributed evenly over the widest possible surface, making for high strength and resistance to fatigue, and permitting the use of thin metal skins which would distort if riveted or welded. Smooth outside contours, so important in high speed aircraft and space craft, become feasible. Two different metals may be joined without creating corrosion problems. With the proper adhesives, the bond is resistant to liquids such as water and fuel.

Among organic adhesives, the epoxies are pre-eminent in many ways:

(1) **Adhesion.** Chiefly because of their content of hydroxyl, epoxy, amine and other polar groups, epoxy formulations have excellent adhesion for metals, glass and ceramics. The resins can be formulated to give mixes of low viscosity with good wetting action. Because of the variety of functional groups in the cured resins, they give strong bonds not only

between two inorganic adherends, but between inorganics such as metal or glass and organic plastics such as phenolics and polyesters.

(2) **Cohesion.** The epoxies react readily with curing agents which transform them from viscous liquids to hard, cross-linked solids having high cohesive strength. Often the cohesive strength within the glue line is so great, and the adhesion of the epoxy to other materials so good, that failure under stress occurs in one of the adherends rather than in the epoxy or at the interface.

(3) **100% solids.** Unlike the phenolics and some other resinous materials, the epoxies cure without releasing water or other condensation by-products. This makes it possible to bond the epoxies at only contact pressures, or with no pressure at all. Also, since there is no water to remove (as with rubber latices) and no volatile solvent (as with nitrocellulose cements), the epoxies are convenient for the assembly-line bonding of impervious surfaces such as metals and glass.

(4) **Low shrinkage.** The epoxies cure with only a fraction of the shrinkage experienced with polymerization-type bondants such as the unsaturated polyesters and acrylics. Consequently, less strain is built into the glue line, and the bond is stronger. Also, the epoxies do not pull away from glass fibers as the polyesters do. The shrinkage can be reduced still further by incorporation of silica, alumina, asbestos and other inorganic fillers.

(5) **Low creep.** The cured epoxies, like other thermoset resins, maintain their shape under prolonged stress. In this respect they are superior to thermoplastic adhesives such as polyvinyl acetate, nitrocellulose, polyvinyl butyral, etc.

(6) **Resistance to moisture and solvents.** Unlike proteins, starches, dextrins, gums, and polyvinyl alcohol, the epoxies are insensitive to moisture. Their resistance to solvents is also outstanding, and accounts for their rapid advance in the coatings field.

(7) **Can be modified.** The properties of epoxy adhesives can be changed by:

(a) selection of base resin and curing agent;
(b) alloying the epoxy with another resin; or
(c) compounding with fillers.

No adhesive is perfect. Chief disadvantages of epoxies are:

(1) **Possible toxicity.** Some of the curing agents are allergenic to some people. Remedies: formulate with nonirritating hardeners, avoid body contact, shift sensitive individuals to other jobs.

(2) Most adhesive formulations must be mixed shortly before use, as they have *low pot life*—30 minutes to 8 hours—once the curing agent comes in contact with the resin. Remedies—mix small amounts; mix larger quantities with the help of automatic mixing and dispensing equipment.

(3) **High cost** has been a drawback for some bulk uses of epoxies. Recently, the resin manufacturers have reduced the prices of the common liquid epoxies by 20%. Epoxies lend themselves to loading with high proportions of cheap fillers such as sand and calcium carbonate, so that the formulated cost compares favorably with other materials. In any case, the cost of the material in a thin glue line is seldom an overriding consideration in adhesive bonding applications.

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Dura-Weld is a creamy, viscous, easy-spreading liquid, tinted to a greenish shade. It does not discolor or stain the materials applied to it. It possesses superior strength and flexibility, and is fast-drying. Damp walls pose no problem. It cannot, however, be applied to water soluble paints, glue, casein sizes, or wallpaper. Age does not crack Dura-Weld; it remains tough, and will not ferment or decompose on long standing. It is highly resistant to most acids and alkalies, will not burn, is vermin-proof, and non-toxic. Dura-Weld, when mixed with mortar cements, increases their tensile strength and extensibility. Patches are more flexible and tougher, supplier states. *Penn Crete Products Co.* P-13

Latex Contact Adhesive

"Javatex", a latex-type contact adhesive for laminating formica to wood and other surfaces, has been announced. It is non-inflammable, unlike solvent type contact adhesives; is claimed to be much more economical to use since it spreads further; and is easily applied by brush, roller, or spray.

Since Javatex is a latex-base adhesive, water can be used as a thinner instead of solvent. Brushes or trowel used to apply same are easily washed with water. However, it is formulated so that once dry, it is resistant to water and solvents.

Javatex has excellent aging qualities and continues to improve with age. It also has good heat resistance and long shelf life. Formica adhered to wood, metal or walls results in such an excellent bond that in trying to remove same, the formica will break before the bond gives. *Java Latex & Chemical Co.* P-14

Foam Splicing Adhesive

A new foam splicing adhesive, Bondmaster R275, incorporates a unique synthetic polymer that is claimed to contribute unusual spread characteristics to the bonded foam. Without sacrificing bond strength, the adhesive is reported to easily attain substantially thinner "glue lines" than were previously possible with conventional adhesive formulations.

Applying foam splicing adhesive.

The ability to achieve thin glue lines without detrimental effect on bond strength results in various advantages: greater yield per gallon of the adhesive, thereby lowering materials costs; faster "grab," leading to increased production speed; avoidance of dimpling, one of the most serious hazards in foam cushion manufacture, and maximum softness of bonded seams, resulting from excessive glue line thickness.

Another unusual feature claimed for the adhesive is the ability to bond almost all types of urethane foams (both large- and small-celled), natural latex rubber foams and sponge to themselves and to each other with bonds that are stronger than the foams or the sponge being mated. *Rubber & Asbestos Corp.* P-15

Sandwich Construction Adhesive

Trade named "Narmtape XP-108", a new adhesive has been designed specifically to eliminate the need for core priming in aircraft and missile sandwich component fabrication. The adhesive consists of a nylon carrier impregnated with a modified phenolic resin and over-coated on one surface with a highly mobile filleting resin. According to the producer, the addition of the filleting resin eliminates one of the most time-consuming steps in the fabrication of a wide variety of aircraft missile structures of bonded sandwich design. The adhesive is claimed to have good peel, tensile, compressive and flexural strengths. It is also said to have good resistance to aircraft fuels, salt spray and commercial solvents. *Narmco Resins & Coatings Co.* P-16

Perfex Bookbinding Adhesive

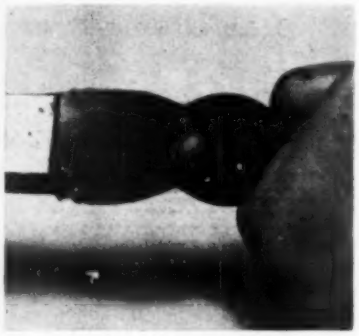
"Perfex", a new bookbinding adhesive, is a cold bonding water base product with exceptionally quick grab. A strong bond is obtained within five seconds after the adhesive is applied, the manufacturer states, emphasizing that it is now possible to completely eliminate the use of staples even on coated stock. Perfex does not have to be heated like glue and is permanently flexible. It does not become brittle or crack with age. It bonds so fast that covers do not shift during the lapse of time between contact with the adhesive and folding. Pages torn out of books bound with this new adhesive show a fiber tear considered most desirable by bookbinders. *Adhesive Products Corp.* P-17

Epiphen Modified Epoxy

Epiphen modified novalac epoxy resins are now in production in commercial quantities. They range in viscosity from 2,000 cps to semi-solids. Epiphen epoxies can be room temperature or heat cured to yield excellent chemical and heat resistance. Heat distortion temperatures in excess of 500°F. have been attained without fillers. Adhesion to both porous and non-porous materials is described as extremely good. Application field tests show that formulations based on Epiphen resins are excellent for plastic tooling, coatings, structural glass cloth laminates, body solder kits, adhesives, and encapsulation. *Resins and Chemicals Dept., Borden Chemical Co.* P-18

Adhesive for Silicone Rubber

A new silicone rubber adhesive material is said to be easily applied and to offer high bond strength. Identified as Silastic Adhesive S-2200, the material is translucent, non-toxic, contains no solvent, and may be applied with knife or spatula.



Silicone rubber-metal bond.

Designed to bond vulcanized silicone rubber parts, Silastic S-2200 is said to create a strong bond in only 5 minutes at 240° to 270°F. The new adhesive is also recommended for bonding silicone rubber to a variety of common metals. However, optimum adhesion to metal requires a cure of about four hours at 480°F. under firm contact pressure. Good adhesion is reportedly obtained with shorter cures through the use of A-4094, a silicone primer which air-dries in 30 minutes.

No special surface preparation for S-2200 is required beyond normal cleaning. Because the adhesive is solventless, parts may be assembled immediately upon application. Tests indicate that cured films develop strengths in the order of 25 pounds pull per inch width and retain both mechanical strength and full resilience at temperatures ranging from —70° to 500°F. *Dow Corning Corp.* P-19

Spot Label Glue

A hot-melt spot label glue for can labeling machines that will work on both hot (160°F.) and cold (40°F.) cans and bottles has been announced. Its performance on this wide range of can temperatures eliminates the need to clean and refill the gum pot when can temperatures are changed. The ultra-versatile adhesive, called "M-P No. 144 Spot Label Glue", also works exceptionally well as a regular hot pick-up gum. It will machine at more than 500 cans per minute on any standard labeling unit, and apply a permanent bond.

In over a year of field testing, No. 144 has been found to offer the canner or packer complete freedom from changing the adhesive in the hot gum pot, regardless of the conditions. For example, even when changing from No. 10's to wrap-around cans, the same M-P No. 144 Spot Label Glue will provide bonds with excellent strength, flexibility, and water resistance. In addition, it allows work from the hot cooker line and cold rework line to be mixed indiscriminately without affecting the strength of the label bond. No. 144 is a resin adhesive containing chemical additives, with a melting point of 225°F. and a fast bonding or setting time. *Morningstar-Paisley, Inc.* P-20

Elastomeric Base Adhesive

A new elastomeric base adhesive, said to produce very high strength bond without heat or pressure is now on the market. It is a light colored material which can be used to laminate plastic, steel, aluminum, wood and other materials. It is used in industrial operations, such as those of bonding decorative plastic laminates to metal counter and table tops, for nonload-bearing sandwich panel construction where plastic, steel, or aluminum facings are bonded to paper honeycomb cores.

Bonds produced by the adhesive have exceptionally high dead load shear strength, high peel strength, and excellent resistance to cold flow. This adhesive also is said to have excellent water resistance and to retain strength and adhesion at temperatures over 200°F. *Adhesives, Coatings and Sealers Division, Minnesota Mining and Mfg. Co.* P-21

All-Purpose Adhesive

A newly developed adhesive is said to make it possible to use adhesives where they were not practical heretofore. Called "Self-Stix", it is a water base adhesive that can be applied to walls, wood, metal, plastics and other surfaces which, upon drying, acts like a strong pressure-sensitive tape. This makes it possible to adhere decorative vinyl plastic, wallpaper, all types of fabric, burlap, and other materials, merely by placing them in contact with the coated surface. P-22

FOR MORE INFORMATION on the new adhesives described here, use the Reader's Service Card elsewhere in this issue.

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TALK OF A NEW BUSINESS BOOM IS BEGINNING TO CROP UP among economists and government officials. They're pondering the chances of another spate of feverish, speculation-filled activity—not just a steady rise in business. To be sure, relatively few of the experts think the present upturn will "go through the roof" next year. Still, the possibility is worth study because renewed boom would call for major buying and other decisions by businessmen. Government officials would have to take tougher measures to fight inflation.

What prompts all the talk of new boom is the rapidity of the business pick-up that began last Spring. It has been greater than the other two postwar recoveries. In fact, industrial production has made up three-quarters of its recession loss in just a few months. If the pick-up were to go on at this rate, we'd be in the midst of a boom before 1959 is very old.

Several things make economists doubtful that a new boom will develop. For one thing, officials have tightened money very considerably since Spring. This could slow down housing and business investment. (There's an excess of capacity in just about every line, anyway.) And, once industry has rebuilt its inventories, its orders may fall, slowing momentum some.

CHRISTMAS SALES WILL MAKE MERCHANTS HAPPY. Volume won't be really boomy, though it will be up a quiet 2% or 3% over last year's holiday buying. Certainly, the stage is set for a moderate pick-up. More folks are working these days...at longer workweeks...and styles are new in clothes and autos. Also, many families are ready to start up on buying put off during the slump.

- Soft goods will show relatively small gains over the sales racked up during Christmas of 1957—2% for clothing, 3% or 4% for shoes, 2% for home-furnishings, and 5% for food-liquor.
- Hard goods will improve faster. Bigger home sales will lift furniture sales 3% or 4%. Appliances will benefit, too. Auto sales will show more life than earlier this year, though they won't match last Fall's. Auto accessory sales will continue strong. Building supply sales should do some 5% better.

SOME REDUCTIONS IN THE RAILROADS' FREIGHT RATES will be made soon. The roads have long wanted to recapture the business lost to trucking lines. This past Summer, Congress gave them the go-ahead—saying that they can set rates now even if the new rates under-cut those of competing transportation. Currently, first applications for permission to cut are reaching Washington. The first drops will come in the Midwest on bulk items such as steel scrap.

ANOTHER HIKE IN FIRST CLASS POSTAL RATES is being drafted by postal officials for submission to Congress next year. The new figure would be 5¢ an ounce—instead of the 4¢ that took effect in August. Mail going over 200 miles would automatically go by air, at the 5¢ rate. But soundings indicate that Congress won't approve any hikes so soon after this year's increases.

Continued on Next Page

capitol cues

FINAL RULES FOR REPORTING BUSINESS EXPENSES for tax purposes have now been issued by the Treasury Department. After all the fuss the question had raised, the new rules require little change from old accepted practices. Before Treasury officials finally backed off, they insisted that employees report reimbursements for expenses as income, then deduct amounts paid out. Now, you don't have to report any reimbursed allowances on your tax return if you are already accounting for expenses to your employer or your company.

Detailed reports are still required in three cases:
- When expense money is not reported in detail to the company.
- When expenses exceed allowances and the excess is deducted.
- When the employee owns a share of the business employing him.

NOTE THE NEW RULES GIVING PARTNERSHIP TAXATION to small corporations just issued by the Internal Revenue Service. They let businessmen enjoy the advantages of incorporation while escaping unfavorable tax consequences. In a word, a firm can have limited liability and the continuity of a corporation (even when a principal withdraws) and still avoid double taxation of the corporation's income. Also, when a business incorporates, its owners can become "employees" and deduct costs of health, pension, and insurance plans.

To get these benefits, a corporation must be an independent, domestic company having no more than 10 stockholders and only one class of stock. The corporation must notify Internal Revenue of its desire to take advantage of the new rules in the first month of its taxable year, or in the month that just precedes this. It simply fills out and files Form 2553.

VICE-PRESIDENT NIXON'S PROPOSALS FOR TAX CUTS for corporations and high-bracket individuals are getting intensive study by tax experts. Nixon is playing an ever-larger role in shaping government policies now—and may have a bigger one in two years. This automatically gives his ideas weight.

The Vice President has suggested imposing an excise on all manufactures, in addition to the cuts in corporate and high-bracket incomes. His aim is to free more money for investing in industry, by taxing away less of it than is taken today.

But the new Congress that will meet in January is certain to ignore Nixon's suggestions. Its liberal majority will say that the plan would shift the tax load to lower brackets. Democrats will have the votes to kill it—this year. But this is one of those ideas that don't die easily, and may fare better in 1960.

BUSINESS WILL TAKE A BIGGER HAND IN POLITICS FROM NOW ON. This sort of thing has been brewing for years, prompted by fear in industry that labor is being given a clear field to put over its own philosophy. The GOP defeat in Maine was the last straw for many business leaders. Now, they are ready to take the offensive and have begun to map their strategy.

What counter-measures do businessmen have in the works?
- Asking stockholders to note company interests when voting.
- Trade association action to raise money to inform workers.
- Encouraging executives to enter rough-and-tumble politics.

The chances are, our doctors tell us, that one in every four of your employees (whether key executives, skilled workers, experienced secretaries or valued clerks) will develop cancer at some time in their lives. What is worse, many of them may die **needlessly,** unless they know how to guard against it. To help save the lives of more of your fellow-workers, call or write our nearest office for information about a free employee education program, geared to your particular factory or office.

American Cancer Society

Postage Stamps That Stick

An improved dextrine product permits more efficient and less costly government operations

By ROBERT W. BOND

Manager, Sales-Service Dept.
Corn Products Sales Co.
17 Battery Place, New York, N.Y.

For more than fifty years the gum on the back of U. S. stamps was largely a tapioca mixture. This was not an American grown plant. Now, at last, we can say that our stamps are all-American.

Lighter colored, with high gloss and bland taste, the new adhesive remoistens easily and adheres securely. It possesses greater uniformity and more stability in solution, even at solids as high as 65 per cent.

United States postage stamps now have an all-American adhesive. Manufactured in the U. S., it's a new improved dextrine made from white milo starch, a product of the nation's farms. Previously, the Bureau of Engraving and Printing in Washington, D. C., which prints the stamps, used a dextrine made from a blend of imported tapioca starch and corn starch.

The new dextrine is manufactured at Argo, Ill., through an improved vacuum process by the Corn Products Refining Co., and is said to possess the requisite remoistening and adhesive characteristics, together with an exceptionally stable viscosity in solution, which are big advantages to the Bureau in its manufacturing operations. Adhesive solutions made with the new dextrine do not thicken up on standing, even during long weekend shutdowns, and therefore do not clog pipe lines and overload pumps.

Sheets of stamps made with the new adhesive don't stick together or block. High relative humidity can make blocking a serious problem.

Decisive in the Bureau's choice of corn dextrine, once it had met all specifications, was the fact that, even with its advantages, it was actually less costly than the adhesive previously used by the Bureau, which had been a dextrine made from a blend of imported tapioca starch and corn starch. As a government agency, the Bureau awards contracts on competitive bidding, and this improved dextrine was offered at the lowest bid price. The next closest bidder offered two grades of dextrine, both more expensive.

Foreign Supplies Unnecessary

Unlike the previous product, the new dextrine is manufactured in the United States from a raw material produced on U. S. farms. This frees the Bureau from dependence on foreign sources of tapioca.

The tapioca starch used for making prewar dextrine came from sweet white cassava produced in the East Indies. After Pearl Harbor, of course, this source was suddenly cut off.

Director Henry J. Holtzclaw, the career man with 40 years of service who heads the Bureau of Engraving and Printing, recalls how he had to appeal to the War Production Board many times to get the WPB to divert cassava dextrine to the Bureau for stamp production. This critical wartime shortage spurred postwar efforts to develop a domestic source of dextrine.

Turning out the nation's postage stamps takes over one million pounds of dextrine a year, according to Mr. Holtzclaw. Just to gum a single 3 cent stamp or others of the same size, takes 0.012 grams of adhesive. Obviously, larger stamps require more. One pound of dry dextrine is enough to furnish adhesive gum production-wise for the back of 50 to 60 sheets of 400 stamps each.

High gloss, light color and bland taste are other desirable characteristics of the new stamp adhesive. Once the Bureau put peppermint on a few stamps to test the public's reaction. The idea was dropped when too many people wanted other flavors. Stamps gummed with dextrine can be remoistened easily, and they stick firmly to letters and other mail. The new dextrine also possesses high solubility in cold water, actually exceeding 99.5 per cent.

Improved performance of the corn dextrine results from the choice of raw material and the special process employed. It is made from white milo starch. This starch is high in amylopectin, with inherent characteristics that produce a finished dextrine which is easily remoistened without washing off. The finished dextrine contains less of the unwanted hygroscopic reducing sugar which is present in the normal dextrine processed by the usual methods now in use. It gives a gum film that is flexible. Its elasticity compares with that usually obtained only with animal glues. It doesn't crack or craze. It adheres better when applied.

The superior remoistening characteristics of the finished dextrine

FIG. 1—Workers unload 100-pound bags of dextrine and stack them near mixing kettles. One pound of dry dextrine is enough to furnish adhesive for the back of 50 to 60 sheets of 400 stamps each; FIG. 2—A gum room operator carefully adds content of 100-pound bag of new corn dextrine to solution he is preparing in copper mixing kettle; FIG. 3—The operator carefully adjusts valve controlling flow of steam to jacket of copper kettle in which dextrine solution is made; FIG. 4—The foreman of rotary printing at the Bureau of Engraving and Printing inspects gum solution in copper mixing kettle; FIG. 5—A printer watches dial showing printing pressure and makes necessary adjustment; FIG. 6—Here moving web of newly printed stamps enters gumming unit on Cottrell press. Adhesive solution made with new dextrine is picked up from electrically heated gum fountain by revolving stainless steel roll partially immersed in gum; FIG. 7—Rotary printing foreman (left), the superintendent who heads the Bureau's Ink Manufacturing and Testing Division (center), and the Baltimore representative of Corn Products (right), seem pleased with quality of adhesive on roll of freshly printed stamps just off the press.

can also be attributed in large measure to the more uniform product produced by the process, as can the reduced setback. The dextrine is also more free flowing and lighter in color due to the improved cooking process used to convert or dextrinize the milo starch.

At Argo, the milo dextrine is manufactured by an improved vacuum process in one of a battery of large cookers or converters. The converters are equipped with agitators, and are jacketed for heating or cooling. The entire five-stage process takes place under vacuum in these cookers with continuous agitation for uniform heating.

In this conversion or dextrinization process, the white milo starch is first modified with acid, then further broken down or degraded by heat to produce dextrine. Each step is carefully controlled.

After the finely powdered milo starch has been placed in the cooker under vacuum, hydrochloric acid catalyst is introduced as hydrogen chloride gas. Chemical modification of the starch is initiated by the acid. The starch is continuously dehydrated by heating under vacuum until almost all free water has been eliminated. The elimination of water takes less time under vacuum than it would if heated without vacuum. Throughout this initial dehydration, the temperature is kept below the dextrinization temperature so that no paste or lumps can form.

Next, the dehydrated preliminary conversion product, still under vacuum in the cooker, is thermally degraded by roasting or torrefying at elevated temperature. Roasting in absence of air prevents oxidation and discoloration.

Molecular Breakdown

Torrefaction, in a series of reactions, breaks down the large molecules, converting them uniformly into dextrinization products intermediate between starch and sugar. Any sugar formed largely recombines or reverts to dextrine type products toward the end of the process.

Conversion is carefully controlled throughout by adjusting the time-temperature cycle. Heating is continued until the desired degree of dextrinization has been reached. Then the product is cooled under vacuum and the batch is discharged.

The final product is a light tan powder that gives a pale solution. It is unusually stable against retrogradation, with just the right combination of high water solubility and viscosity characteristics, plus an absolute minimum of hygroscopic reducing sugar.

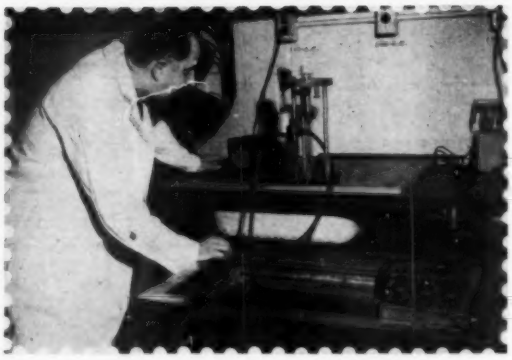


FIG. 8—A chemist determines the viscosity of a 65 per cent solids solution of the new dextrine at 25°C. in Stormer viscosimeter. Viscosity is measured 3 hours after the solution is made and again after standing 72 hours at room temperature in an airtight beaker.

The improved cooking process employed has many advantages. Since air is excluded, it achieves a greater degree of conversion or dextrinization without discoloring or darkening due to oxidation. It is no longer necessary to rush the conversion to avoid color development. Instead, time can be taken to carry the dextrinization far enough to get the desired properties.

Previously, it was almost impossible to produce a light colored dextrine highly soluble in water without using strong degradation. And strong degradation resulted in an objectionably high per cent of unwanted hygroscopic reducing constituents.

The process can be controlled more closely for efficient operation. Control of acidity is improved. Temperature at any stage can be pinpointed. Cooling equipment has been specially designed. No air enters until the hot product has been brought down in temperature.

As a result of this close control, greater uniformity is attained. A single product tends to predominate. The finished dextrine exhibits a more homogeneous molecular structure, with similar branching and uniform chain length throughout the polymer.

Because the converters at Argo have larger capacity than the individual cookers commonly used, the uniformity of product from bag to bag is greatly improved. Moreover, the vacuum process enables the manufacturer to produce a dextrine tailored for its specific job.

The Argo plant ships the dextrine in multiwall paper bags, each containing 100 lbs. To stay within the Bureau's 3 per cent maximum moisture requirement, the bags are laminated with asphalt.

The dextrine arrives at the Bureau in box cars, with 500 or more of the 100-pound bags in each shipment. From the box car, bags of dextrine on skids go first to the storage area and from there are brought up by elevators to the gum mixing room and stacked.

There are eight steam-jacketed copper kettles in the gum mixing room, three for mixing, three for storage, and two for circulating the adhesive solution. The mixing kettles each have a sweep type agitator with a scraper that just clears the inside wall of the kettle. A pair of oppositely pitched paddles rotating counter to each other furnish agitation for mixing the gum solution. A 1.5-hp. motor drives the agitator on each kettle. The agitators rotate at 40 to 45 rpm.

Producing Gum Solution

In making gum solution, enough water is metered into the kettle to give a finished solution of 65 per cent solids, based on dry dextrine. Residual moisture content of the dextrine is determined daily, and the volume of incoming water adjusted. Using 700 pounds of dextrine, it usually takes about 50 gallons of water to make the solution.

Water is heated to boiling in the steam-jacketed kettle. Then the dextrine is added gradually, with the steam off, but with continuous mechanical agitation. After about two-thirds of the dextrine has been added, the steam is turned on to bring the temperature to 185°F. The balance of the dextrine is added and the batch is cooked for 30 min. Then the steam is shut off, while mechanical agitation continues for another 45 min. The gum mixing cycle thus takes 1¼ hrs. after all the dextrine has been added.

When necessary, the water content is adjusted to compensate for loss by evaporation and to attain a 65 per cent solution based on actual solids. The Bureau has determined experimentally that at 65 per cent solids the gum solution is about as thick as it can be made while still retaining the requisite flow characteristics.

From the cooker, finished gum solution is pumped into a storage kettle until needed. A Quimby rotary pump circulates the liquid adhesive from kettle to kettle in the gum room. Operating at 50 psi., the pump can handle 25 gpm. It is driven by a 2-hp. DC motor.

When ready for use, the gum solution is pumped from one of the kettles in the mixing room to the gum fountains on the Bureau's new Cottrell rotary intaglio presses under 90 psi. pressure through a 2-in. copper transfer line insulated with asbestos. A pair of Quimby rotary pumps with 3-in. screws are used to move the adhesive solution. Each of these heavy gum pumps is driven by a 5-hp. DC motor, and can handle 10 gpm.

Gum enters the gum fountain on each press from the asbsestos insulated circulation system through a brass tube with a screened perforated nozzle at its tip. A valve above the nozzle is adjusted manually to regulate the flow of gum into the fountain, which holds about one gallon of the adhesive solution. The gum has a viscosity of appproximately 125 poises at 25°C. It is kept at 105°F. in the fountain by electric heating.

From the fountain, the gum is picked up by a revolving stainless steel roll partially immersed in the gum. This gum roll applies the gum evenly over the back of the moving web of newly printed stamps. Gum thickness on the stamps is critical, and is kept between 0.0007 and 0.0009 in. by automatic scanning and manual adjustment whenever necessary.

There must be enough gum on the stamps for good adhesion when the stamps are used. However, if the gum film gets too thick, it can cause trouble on the press by drying and sticking to the rollers.

Next, the freshly gummed web passes overhead through the electrically heated gum dryer oven. A pair of fans circulates hot air through the oven, which is heated by a series of 24 fin type Cal rod heaters.

The gum must be dried in only 8 sec. since the web is moving through the oven at a speed of 150 ft. per min. The oven is about 10 feet long, and the gum must be completely dry after the web has made two passes through the oven, a total distance of about 20 ft.

Automatic Temperature Control

Drying is controlled electronically. An automatic temperature controller-recorder of the potentiometer type maintains the temperature in the gum drying oven on the press at 350°F. The oven is also equipped with manual controls.

From the gum oven, the web emerges with gum, ink and paper completely dried. It then passes over cooling rolls, and is finally rewound into a roll.

It takes about 1½ hours to complete a single roll on one of the Cottrell presses. When plates printing 400 stamps per impression are used, each finished roll has 3 million stamps on it. Rolls of printed stamps go to specially designed perforating and sheeting machines at the Bureau. Some stamps are not cut into sheets, but are wound into coils.

From the standpoint of the bureau's manufacturing operations, by far the most important advantage of the new dextrine is the exceptional stability of its viscosity in solution. Unlike some other solutions previously used, it does not tend to thicken upon aging. In fact, even though the Bureau allows an increase of 100 poises in the viscosity of the gum solution after standing 72 hrs., solutions made with this corn dextrine often show remarkably slight viscosity increases of less than 10 poises in that period—far below the permitted maximum.

Because any setback or increase in the viscosity of the gum solution causes serious operating difficulties, making the gum hard to pump and difficult to apply, the Bureau further requires that the dextrine solution, after standing five days in a covered container, must not become so viscous that the cold solution cannot be pumped through the gum lines at the Bureau without overloading the gum pumps.

Previously, the Bureau occasionally encountered trouble due to such thickening. Now, however, even after week-end shutdowns or longer layovers, when gum in the lines and kettles becomes cold and tends to thicken, adhesive solution made with the new dextrine remains fluid in the gum lines. Since it will still flow, the 65 per cent solids solution can be circulated without trouble by the pumps, and when applied it adheres readily to the paper.

This corn dextrine, according to Kenneth W. Stroad, superintendent of the Bureau's Ink Manufacturing and Testing Division, which makes ink and tests paper and gum, meets all technical and functional requirements, and is somewhat lower in cost. Its ash content is below the Bureau's minimum of 0.15 per cent.

Schematic sketch showing the process for printing and gumming postage stamps.

It contains less moisture than the 3.0 per cent allowed, and is slightly less acid. It has less reducing sugar.

It is remarkably stable in viscosity, according to Mr. Stroad. With an increase of 100 poises allowed on standing 72 hrs., one shipment of the new corn dextrine in 65 per cent solids solution increased only 6 poises in viscosity.

Bland Taste Cited

In Bureau tests, the milo dextrine has been judged to have lighter color and higher gloss than the previous adhesives. Its taste is bland. It remoistens satisfactorily without requiring excessively vigorous moisture application, unlike many other gums, and has good tack and adhesion. Sheets of stamps gummed with the new dextrine show little tendency to block. Blocking means sticking together of sheets, and is more likely to occur at higher humidities.

One of the most critical tests on the gum is the measurement of its increase in viscosity or setback. The viscosity of a 65 per cent solids solution of the dextrine is measured at 25°C. with a Stormer viscosimeter three hours after preparation and again after standing 72 hrs. at room temperature in an airtight beaker. The maximum increase in viscosity allowed by the Bureau for this interval is 100 poises. Surprisingly, this dextrine solution often increases less than 10 poises.

Per cent purity of the dextrine, determined by polariscope, must be at least 84 per cent. Dextrine in solution rotates the plane of polarized light to the right. In fact, that's how dextrine got its name. The angle of rotation on the Ventzke scale ranges from 44° to 48° for the 10 per cent dextrine solution used. The Bureau's specification calls for not less than 45.5°.

The solution may contain, besides dextrine, soluble starch and also reducing sugar. Therefore, the reducing sugar in the dextrine solution is determined separately to the dextrose with Fehling's solution. An allowance is then made for the optical activity of the sugar in arriving at the per cent purity of the dextrine. The starch is optically inactive.

Reducing Sugar

Reducing sugar in the dextrine, determined as dextrose, must not exceed 3.0 per cent. Too much reducing sugar, Mr. Stroad explains, increases blocking of finished sheets of stamps because reducing sugars such as dextrose are hygroscopic. Reducing sugar in this corn dextrine is amazingly low, seldom higher than 2 per cent.

Serving as it does the nation's highly vocal citizens, the Bureau of Engraving and Printing must be ever alert to safeguard the quality of the stamps it produces. Today the Bureau designs, engraves and prints 25 billion postage stamps a year to meet the needs of close to 37,000 post offices throughout the United States. And the new adhesive made with corn dextrine is helping the Bureau to do an effective job of gumming this tremendous output of stamps.

Thorough Testing

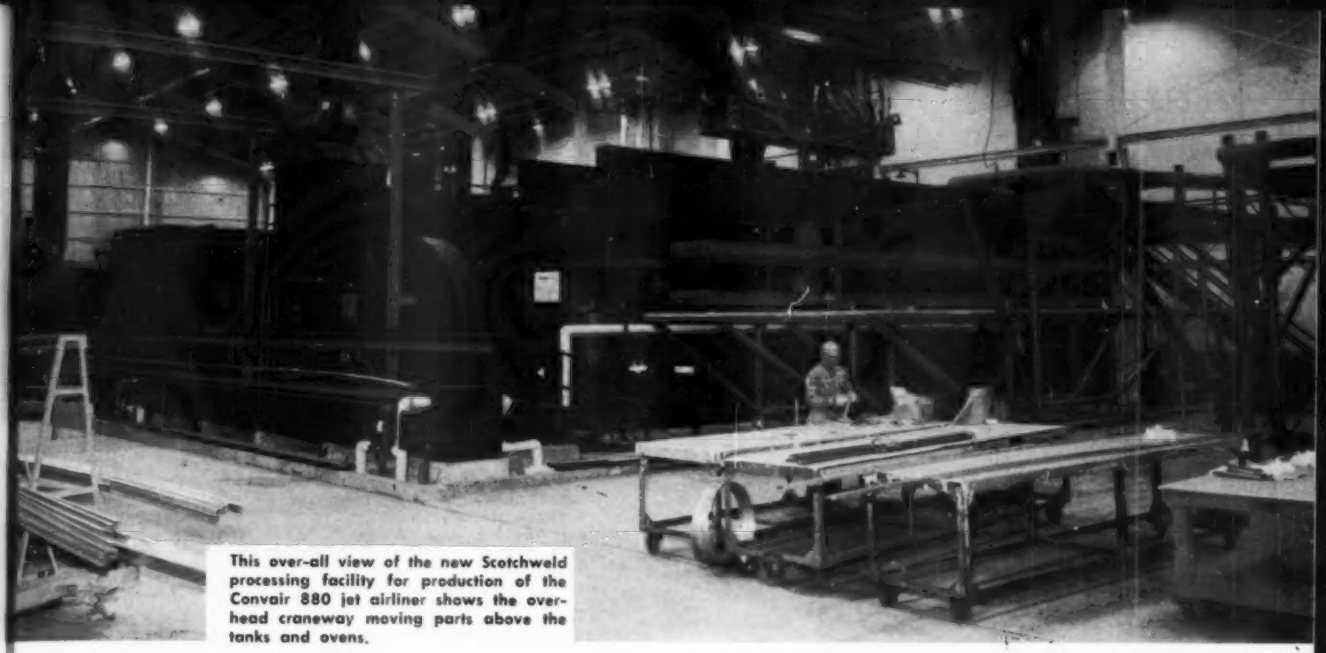
Before the new dextrine was used in regular production, it was thoroughly tested in the Bureau's laboratories and then underwent actual manufacturing trials. Corn Products began its service to the Bureau in June 1957, furnishing small test quantities. In August 1957, Corn Products furnished a 10,000-lb. shipment, and the first eight-hour trial run was made on September 9, 1957. After the new dextrine had met all laboratory tests and performed successfully in full scale manufacturing operations, a contract was signed.

Notes: Quimby rotary pumps are manufactured by the Quimby Pump Division of the Warren Steam Pump Co., New York, N.Y. Cottrell presses are produced by the Cottrell Co., Westerly, R.I.

Robert W. Bond

About the Author . . .

ROBERT W. BOND is manager, Sales-Service Department, Corn Products Sales Company. A native of Cambridge, Mass., Mr. Bond was graduated from the University of Illinois in 1939 with a degree in chemistry, and joined Corn Products Refining Company that same year, going to work at the Argo, Ill., plant. His career with the company was interrupted by World War II, in which he served four years and eight months. From Argo, Mr. Bond transferred to the Corpus Christi, Texas, plant as chief chemist. He later engaged in process work at Corpus Christi. Then, in January 1952, he returned to Argo becoming assistant manager of technical service. He was later promoted to his present position.



This over-all view of the new Scotchweld processing facility for production of the Convair 880 jet airliner shows the overhead craneway moving parts above the tanks and ovens.

Adhesive Bonding of Wing Fuel Tanks

Unique Installation at Convair Permits Rapid and Efficient Wing Assembly

Convair Division of the General Dynamics Corp. has completed construction of a $700,000 installation which permits assembly-line adhesive bonding of integral wing fuel tanks for its new 880 jet transport. The new installation represents the culmination of a basic research project begun several years ago. In the process, wing spars and ribs are bonded to the wing skins with Scotchweld bonding films developed jointly by Convair and the Adhesives, Coatings & Sealers Division of the Minnesota Mining & Manufacturing Co. The 220-square-foot swept wing of the Convair 880 is assembled with strips of dry film adhesives which are bonded between the faying surfaces of the wing skin and structural members.

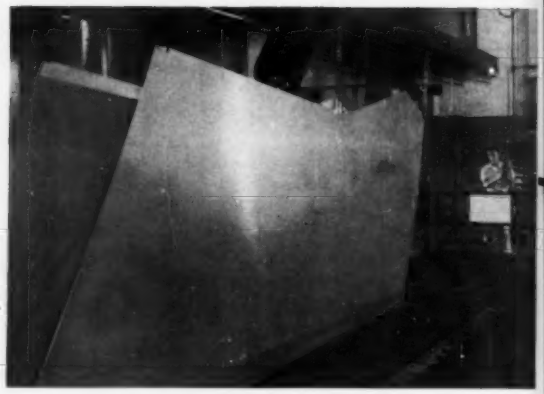
Convair officials point out that the 880 fuel tanks are designed to be leak-proof, maintenance-free and corrosion-resistant, noting that the new process is a dividend on earlier work done on integral fuel tanks of the F-102A all-weather supersonic interceptor. Convair 880 wing structure has been designed so that spars, bulkheads and skins actually form four fuel tanks in each half of the wing. There are said to be four corollary benefits created by the adhesive bonding:

- **Added strength, which compares to that obtained through the use of 3/16-inch rivets. The entire wing structure has been designed to handle all flight loads through the use of standard fasteners. The added strength obtained from the new adhesive process is a bonus.**
- **Prevention of joint slippage because the adhesive shares the load with the rivets. Some movement is allowed without breaking the seal, permitting the fastener to pick up the load.**
- **Added resistance to fatigue.**
- **A more rigid structure.**

In working with the 880, it was determined that the Scotchweld sealing system employed in construction of the F-102 integral fuel tanks was also the logical choice for the Convair 880. The adhesive film involved combined the properties of good heat aging; good low temperature shear; excellent salt water, humidity, and fuel resistance; and the ability to permit some bond elongation without losing continuity. In addition, the metal-to-metal bonding method of assembling aircraft structures provided a bonus in structural strength by distributing loads more evenly over the entire 120-foot wing.

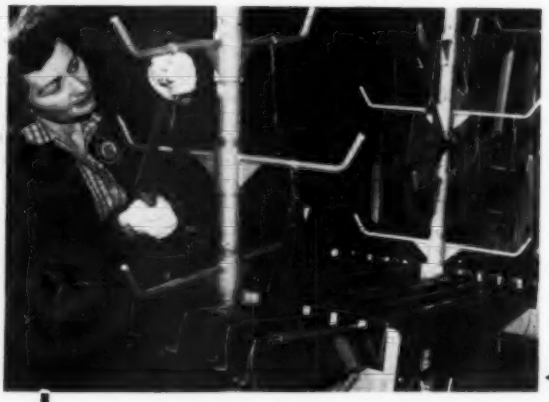
The adhesive bonding of integral wing fuel tanks for the Convair 880

Integral Fuel Tank Assembly at Convair



A Convair 880 wing skin 8 by 27½ feet goes into one of the 10,000-gallon processing tanks for an etch rinse prior to coating with Alodine 600. These processes are preliminary to application of the prime.

This multiple-purpose tank and oven is 61 feet in length. The tank is used successively for soap, acid and rinse solutions, and then becomes a "water-heated oven" for drying and pre-curing at 175°F. in the Scotchweld process.



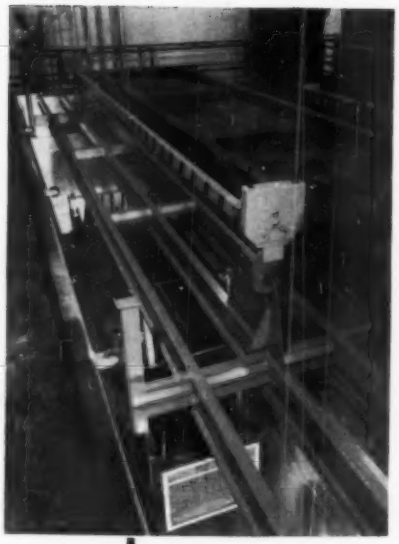
These Convair-designed "Christmas tree racks" utilize horizontal arms which rotate to provide easier loading of parts for Scotchweld processing. The entire cycle takes place in a spotlessly clean facility.

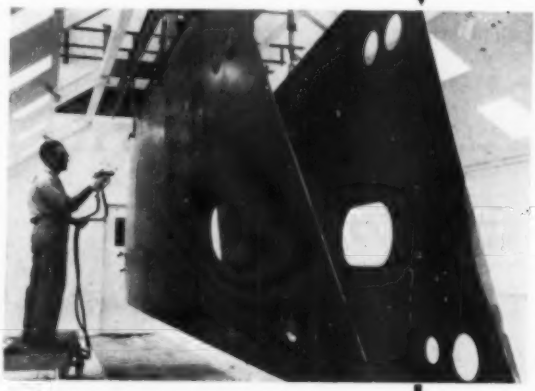
Worker applying adhesive film to faying surfaces.

A workman inspects Convair 880 wing parts on "Christmas tree racks" after completion of processing. During wing assembly, Scotchweld adhesive film is applied to all faying surfaces which will be bonded to form leak-proof, maintenance-free integral fuel tanks in the wings of the jet airliner.

The parts first are immersed for several minutes in the etch rinse to prepare the surface, and then go into this tank of Alodine 600 for one minute to receive a conversion coating which acts as a binder between the aluminum alloy metal and the prime.

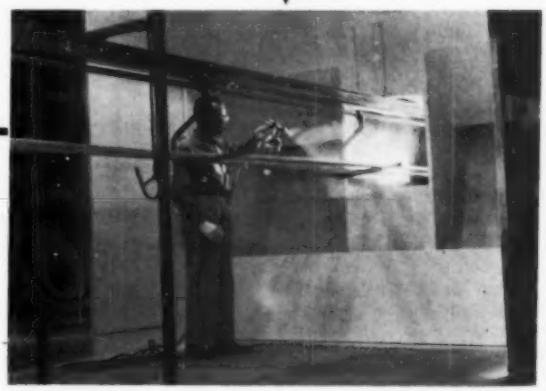
Here, individual parts are lowered into one of the ovens for a 15-minute drying period after having received the Alodine 600 rinse.





Application of prime to the big wing skins of the Convair 880 jet airliner is done in this down-draft spray booth.

A workman sprays prime on parts for the jet airliner in this newly constructed down-draft spray booth. Overspray is carried into a moving stream of water through the iron grill at the workmen's feet. Fresh air is sucked in through the open top of the booth. Automatic timers are used to facilitate the work.



Spar rails for the jet transport receive their prime coat in this spray booth. The spar rails are carried into the spray booth by monorail carrier from a 61-foot multiple purpose tank and oven which prepares them for the prime coat.

is now taking place at the recently completed facility located at the San Diego plant of Convair. Inside this facility are an electric oven 80 feet long, 20 feet high, and 10 feet wide; six 4 x 10 x 35-foot processing tanks; a paint booth; and a three-compartment pre-curing oven. A craneway structure and exhaust fan system are included in the auxiliary equipment.

Each detail and structural part is first cleaned and given an Alodine 600 chemical coating. This is sealed with a thin coat of primer and precured at 150°F., in order to permit handling before the bonding process is begun.

Dry Tape Applied

The 2,000-square-foot swept wing is then assembled with strips of dry tape placed between the faying surfaces of wing skin and structural members. Rivets are then employed to join the skins, ribs, and spars, at the same time supplying the necessary clamping pressure on the tape for the curing process. Gas-tight corners and lightweight self-sealing dome nuts, developed by Convair, the Nutt-Shel Company, and the Franklin C. Wolfe Company for use with inspection covers, complete the assembly of the wing tank areas.

After final assembling of the wing tank, the entire section is placed in the electric curing oven at a temperature of 325°F. The heat melts the flat tape adhesive, and the film then cures to a tough, fuel-resistant barrier between the joined surfaces. The electric oven accommodates two Convair 880 wing-tank sections in one curing operation.

In an area immediately adjoining the facility are located the giant wing bucks used in assembly of the 880 wings. Each of these six fixtures weighs 75,000 pounds, and there are three righthand and three lefthand bucks. Over-all length of each is 90 feet; maximum width is 10 feet; and maximum height is 22 feet. These dimensions reportedly make the fixtures the largest and longest ever made for Scotchweld assembly.

As in previous Convair aircraft, fuel tank accessibility has been emphasized in the over-all wing design. The wing has large removable doors in the lower surface to provide access to system components and to allow inspection of the wing interior. These access doors are of the structural type, and are installed with flush screws and self-sealing, dome-type plate nuts. Structural access doors are designed as part of the basic airframe structure; in other words, they actually carry a part of the wing stress load.

The skins of the wing have milled recesses so that the access doors fit flush with the skin. Fuel tank access doors which are in direct contact with the fuel have molded rubber seals to maintain a fuel-tight fit. The picture story which appears on the preceding two pages shows how the fuel tanks are assembled at Convair.

Note: Alodine 600 is a trade mark of the American Chemical Co.

Adhesives at Sea

Waterproof Bonds Contribute to Sea Worthiness

For the first time in the history of international rivalry for America's Cup, a prominent boatbuilder in this country has called upon modern adhesives and plastics to help put a superior craft into the water. The design of the 12 meter "Weatherly," a sixty-nine-foot American candidate, calls for the use of Bakelite plastic materials to give high strength, water-resistant adhesion and coating, and to provide exact hull configuration, according to the builders, Luders Marine Construction Co., Stamford, Conn.

Designed by Philip L. Rhodes, the Weatherly has a double-planked, mahogany hull. All faying surfaces between the inner and outer planking utilize an adhesive based on Bakelite epoxy resin. The adhesive maintains high bond strength despite the great stresses of ocean racing, and is resistant to the effects of constant immersion. In addition to its use on all contact surfaces and fastening areas, the plastic is applied as a seal between the hull and the 17-ton lead keel.

Luders formulates its own coatings based on the epoxy resins, which are used as a clear varnish directly on the hull, and as the outer pigmented layer. Applied with conventional coating systems, the epoxy material provides tough, resilient protection which is unaffected by constant immersion in salt water and cuts maintenance requirements.

All contact surfaces of the double-planked mahogany hull of the Weatherly utilize an adhesive based on epoxy plastic.

To compete successfully in America's Cup competition, the Weatherly hull must be shaped to perfection. Another plastics material, syntactic foam, was used in this phase of construction. The foam is formulated at the shipyard from Microballoon spheres and epoxy resin. Microballoon spheres, made of phenolic plastic, are extremely lightweight and approximately 0.0017 inches in diameter. When mixed with epoxy, a troweling material is formed. The compound, which has excellent adhesion to surfaces, is highly durable, can be applied easily where needed, and can be sanded and finished.

According to A. E. Luders, Jr., vice-president of the Luders Marine Construction Co., the concern has had long, successful experience with phenolic and epoxy materials. A recent use, similar to that in the Weatherly, was in a fleet of wooden hulled Luders-built minesweepers.

Microballoon is a trademark of the Standard Oil Co. (Ohio).

From Construction to Adhesives

Kawaller

. . . Stuck With a Business They Didn't Know They Had

Nagel

On a recent muggy day in August, the editor of ADHESIVES AGE visited with two gentlemen from Preco Chemical Corp. The conversation vacillated rather strangely across many industries and in and out of many interesting situations. A rough report of that conversation is recorded here. The two gentlemen are Robert H. Nagel, research and development director of the company and Seymour I. Kawaller, sales manager of Preco.

Question: Let's pause a moment here. You say that you got into the adhesives business. How? Did you simply make up your minds that you would become adhesives specialists and entered the field?

Nagel: As a favor to a customer, we agreed to make a "glue that would hold a mirror in a movie projector." We had no idea at the time that, within a few months, the "glue" would become a major part of our business.

Question: Hm-m. What were you doing before that time? You say you had a customer, so you must have been in business.

Kawaller: Yes, we've been manufacturing waterproofing materials used extensively in the building trades. Our products are used as concrete admixtures and specialty masonry coatings. Of course, we are always working to improve our products and are forever seeking new ones. About two years ago, we perfected a cold glazed cement finish[1] as a low-priced replacement for ceramic tile. Fortunately for us, this product incorporates an epoxy resin —which brings us to the adhesives business.

Question: Just like that. There must be hundreds of companies in the United States that use epoxies in their products. They're not all in the adhesives business—and I don't imagine they will be.

Nagel: Epoxies are newly developed basic resin compounds. Nobody knows the extent of their applications nor the fields into which they will be expanded. They have exceptional resistance to acids, alkalies and other corrosives along with additional properties which are advantageous in the building field. They're something like nylon. Nylon can be made into such varied products as rugs, hosiery, ball bearings, etc., etc. The same applies to epoxies. They can be formulated for many, many uses.

Question: Exactly. So why adhesives particularly, Why, in other words, did you drift towards adhesives?

Kawaller: Look. The applications of our cement finish soon opened the way to a special purpose formulation designed to protect chemical storage tanks against corrosive attack. This formulation, based on an epoxy formulation, was soon marketed to meet this need.

Nagel: When tests demonstrated the amazing adhesion of this new material to metals, masonry and virtually any clean, grease-free surface, one of our field engineers adapted the material to a new use in resurfacing a concrete floor. He used a thin, epoxy-aggregate formulation which could be applied over concrete to a feathered edge. Another of our products was derived from this and proved highly successful in difficult installations. Unlike previously used materials, this material[2] could be applied as thin as 1/16-inch without cracking or lifting under heavy traffic conditions. This material has been in wide use and has been valuable to the Navy as well as major industrial users.

Question: Fine, but where does the adhesive picture form?

Kawaller: Well, by this time, all of us at Preco were convinced that we had hitched our wagon to a star. The demonstrated properties of our products were beginning to be recognized widely and, since our formulations were among the first to put epoxies to practical uses, we were soon benefitting from wide publicity obtained through the efforts of our suppliers and customers.

The *New York Times* featured a story of our cold glazed cement finish installation in the famous Brookhaven Atomic Energy Laboratories; the National Arborist Association used a newsletter to advise its members of the advantages of our tank coating[3] for lining their chemical storage tanks; *Maintenance* magazine, *Concrete Products* maga-

zine, *Food Engineering, Pool Development* and many other trade publications were quick to advise their readers of these new products and their related applications.

Question: I begin to see a light . . .

Nagel: In spite of this wide interest, you must understand, we were still primarily interested in epoxies for their value in the building products field. It was only by accident that we realized the tremendous potential for our epoxies in the industrial field.

Question: Ah, now we come to that accident . . .?

Nagel: Yes. Now. I like the way Sy tells it. He's got the facts well lined up.

Kawaller: You know the Obex Camera Corporation? The people who manufacture the remarkable new Wittnauer movie camera-projector combination. Are you acquainted with it? It's that terrific unit that serves both as a camera and a projector . . .

Question: Yes, yes, I've heard of it. Please go on.

Kawaller: Well, they had inquired about the use of our tank coating material to protect a degreaser against corrosive deterioration. In discussing the application with our field engineer, Obex's production head mentioned an assembly-line bottleneck which had forced him to keep our man waiting. Obex had been having difficulty securing a small reflecting prism in the movie projector they were making. None of the adhesives they had tried worked. The mirror had to withstand a wide range of temperatures. They had decided to switch to a much more costly and time-consuming metal-prong device.

Our engineer took a small dab of the material, applied it to one of the mirrors and . . . Obex had solved a problem and Preco had a new product!

Nagel: Of course, back in our labs, we reformulated the material to extend the temperature range under which it would remain stable. We are pleased to report that the product has had constant and successful use at Obex as well as at other firms where it has been introduced.

Question: I like that story.

Kawaller: Wait a minute, there's more. The same material has been used in an entirely different application.

Nagel: Yes, tell him about the pools.

Kawaller: One of our customers is a swimming pool manufacturer. He had been bemoaning the high labor cost involved in building good pools. Our field engineer had been supervising the application of our new caulking compound[4] when he conceived the idea of installing the pool coping with the use of an epoxy-based mortar.

The next day, using the adhesive we had developed for Obex, he made a mortar[5] which was applied like toothpaste around the edge of the pool.

Question: Like toothpaste? What do you mean?

Kawaller: You know, squeezed out of a gun. The coping was then placed in position and allowed to set until the mortar cured. The entire operation took about one and a half hours as compared with the day and a half usually required for setting a pool coping by conventional methods. Obviously, despite the high cost of our mortar, the use of this epoxy mix was more than justified by the huge labor- and time-saving in this type of installation.

Question: Very nice.

Nagel: What's more important is that the coping is more securely anchored since the mortar will not crack and will resist stresses, pool chemicals, water and temperature variations which plague ordinary mortar installations.

Question: You must admit that you've been fortunate to have men on the job who have imagination and originality.

Nagel: Yes, and yet, since getting into the adhesives business, we are constantly amazed at the wide range of problems calling for solutions which we have at our finger tips. Most of these applications consist of applying proven products in new applications.

Question: That's what I mean. Alert and imaginative men have extended your applications and your products.

Kawaller: Occasionally we have to develop a new material from a standing start. Our masonry adhesive[6] is a case in point. This is a latex material that's used to adhere concrete to wood, metal, stone, glass and other sub-strata, permanently.

Mixed into the concrete, it permits a thin-skinned application in areas where a thick slab is not applicable nor desirable. It's low cost makes it practical where high cost epoxies cannot be considered. As a result, this adhesive has been used to resurface spalled concrete floors and roofs. In such cases, considerable savings result over old-time methods of repair.

Question: I must say that this is enterprise and initiative. Imagine a story entitled "The Evolution of an Accident."

Nagel: Our successes have encouraged us to enlarge our field engineering staff and assign to them the job of bringing in problems which our labs then tackle. We've made a specialty of developing adhesive formulations designed to meet specific requirements. What's more, we offer this service gratis. We found it to be good business to be stuck with these problems—and we usually stick with them until we come up with something that will stick on the job.

Question: Oo-oo-oo!

Nagel: I had to get that one off my chest.

Kawaller: I'm glad you did. We might as well leave the corn here.

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[1]Ceramix; [2]Armor-Crete; [3]Tank-Cote; [4]Thioseal; [5]Rock-Weld; [6]Tite-Bond.

About the Messrs. Nagel and Kawaller . . .

Bob Nagel is the 34-year-old president of the 10-year-old Preco Chemical Corp. After three years in the Navy he earned his degree in Chemical Engineering at R.P.I. He then did graduate work at Cornell. After several jobs with companies like Valspar and A. C. Horn, he joined Leonard Sonnenberg and launched Preco. At first, they divided all corporate responsibilities. Today, Len Sonnenberg is responsible for the firm's production and Bob Nagel is in charge of research and development.

Sy Kawaller, at 40 the "old man" of the company, is vice-president and sales manager. He spent his formative years in the advertising business, then a stint in Patton's Third Army in Europe, and back to the advertising field. He backed his abiding confidence in himself with his money and became a member of the firm. He has been married to his first date for more than 20 years and is the proud father of two girls and a boy. He commutes to Preco's New York office from his home in New Rochelle, N. Y.

Some emulsions and latex based adhesives possess high foam potential. The addition of as little as .01 per cent defoamer to the tube at the left eliminated foam formation.

Foaming as an Adhesive Problem

By E. PATRICK McGUIRE
United Paste & Glue Co.,
New York, N.Y.

Slowly a small bubble rises to the surface of the liquid. It is joined by another and another. Foaming has begun and perhaps no other phenomenon presents more of an enigma to the adhesive consumer than this condition. Foaming exists to some extent in practically all adhesives in the water-based field. At times this foaming remains microscopic and for many intents unimportant to the machine performance of the adhesive. When foaming becomes macroscopic or visible to the naked eye it ceases to become a curiosity and becomes a positive detriment to adhesive performance. This evaluation will concern itself primarily with the problem of foam as it affects the ultimate user of the adhesive.

Two Types of Foaming

For these purposes, there are two principal types of foaming that occur in water-based adhesives. The first is caused by a possible internal chemical reaction that occurs producing a gaseous reaction product. The second type of foaming is mechanically induced resulting from the continuous agitation of the adhesive substance by the various machine components acting upon the body of the adhesive. Of these two causes the latter is by far the most persistent and frequent cause of foaming. The design of modern packaging equipment places an increasing mechanical stress on the adhesives that must perform in them. Figure 1 illustrates a cross-sectional view of this type reaction in a typical applicator wheel assembly.

In considering the state of foam one can easily draw an analogy between the foam state and the emulsion state. Foam has sometimes been described as an emulsion in which the dispersed element is gaseous rather than solid. In examining the foam layers in an adhesive you will observe a definable symmetry exists dependent on the volume of air being entrained by the machine components and the escape points at which foam is occurring. As each bubble rises to the surface and presses against its fellows a change in conformation from spherical to hexagonal takes place. The walls or lamina of these gaseous spheres press against each other and meet at tangential angles of 120 degrees.

For most purposes it may be stated that absolutely pure liquids do not foam. Unfortunately adhesives are never pure liquids but rather are mixtures and emulsions of many liquids and solids. Since adhesives are complex mixtures there are at least several causative agents present in any compounded product.

One of the most important single factors operating within the adhesive in relation to its foaming capacity is the surface tension of the particular liquid. Surface tension is present in all liquids and films. Theories based on molecular attraction as well as physical effect have been advanced to account for its existence. It suffices to say here that surface tension plays a vital and indispensable role in whether a subject adhesive will foam or not. Surface tension can best be observed visually by the flow properties of a drop of liquid or the surface curvature this liquid exhibits in a container. Liquids with low surface tensions are near their boiling point and not likely to retain gases entrained in their surfaces.

Self-Dissipating Foam

In many liquids when a foam structure occurs it dissipates quickly without benefit of outside aid. There are measurable forces acting for this dissipation. The film thickness of the lamina ordinarily begins to decrease continually under the weight of the lamina wall and the variances in gaseous pressure exerted on the lamina. In the case of adhesive foam we have a particularly acute problem. The great majority of water-based adhesives are excellent film formers. They are specifically formulated to set and dry quickly when deposited in thin films. For most adhesives these films are flexible in character. Foam formation offers an excellent opportunity for the adhesive to accomplish its design function.

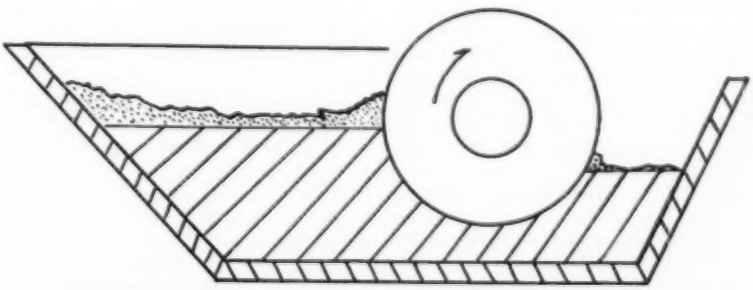

FIG. 1—Cross-sectional view of typical applicator wheel assembly.

The result is a sticky foamy mass deposited on the surface of the adhesive. This dried film of foam particles is nearly impossible to resolubilize and with its accumulation in the adhesive tray the overall performance of the particular machine suffers measurably. It is difficult to estimate what foaming costs in terms of lost production. Careful analysis would indicate that it represents far more than just an incidental nuisance.

Resin Emulsions and Latices

In the use of adhesives based on polyvinyl acetate emulsions the presence of foaming can be particularly deleterious. PVAE adhesives are usually applied at film thicknesses of anywhere between one half and one fifth the thickness of corresponding vegetable adhesives. Since the greater portion of these products are applied at relatively high machine speeds it is not always easy to determine whether a complete application of adhesive is being accomplished. The writer has observed several instances where the applicator wheel was running in a layer of foam and little if any adhesive was being applied. At high machine speeds it is conceivable that several hundred units could pass before the operator becomes aware that a proper film is not being applied.

The formulation characteristics of the resin adhesive govern to a large extent the foaming potential of the adhesive. The larger portion of these adhesive types are constituted from emulsions. Emulsions have a proven inclination to foam more easily than true solutions. The adhesive manufacturers add plasticizers, tackifiers, solvents and many other materials in the process of compounding. In some cases these additives are introduced for the express purpose of reducing the stability of the emulsion and effecting a faster bonding adhesive film. Solvents are frequently added to promote faster penetration of the bonding surface and to encourage a faster setting time. The side result of this solvent addition is often to increase the foam potential of the adhesive.

There are no pat generalizations that can be made regarding the foaming potential of a resin adhesive. Often such seemingly unrelated factors as the type and amount of emulsifier used in the base PVAE will bear partial responsibility for foaming. Polyvinyl acetate adhesives in viscosity ranges of less than 1500 cps are, because of their low viscosity, more easily foamed than the heavy semi-pasty type of resin product. The latter type may experience agitation in the adhesive tray but most of it because of the heavy viscosity of the material is restricted to the area immediately surrounding the applicator wheel. In the case of low viscosity materials a rapidly spinning applicator wheel provides agitation for the entire body of adhesive in the tray.

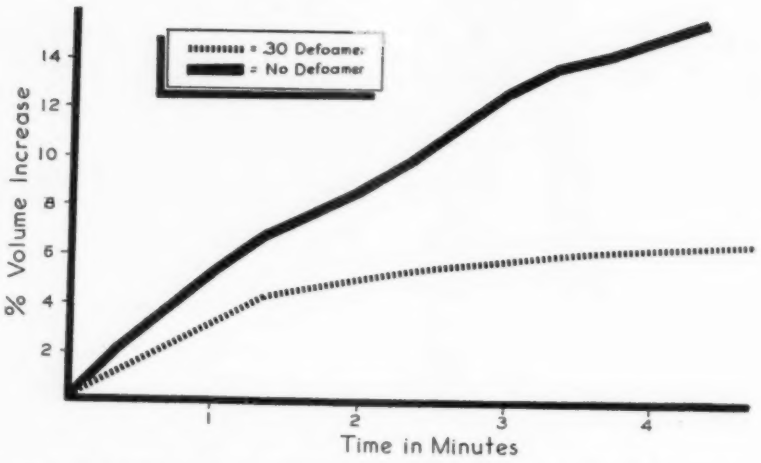

FIG. 2—Defoaming Effects of a silicone emulsion defoamer on a simple adhesive system.

There is an increasing tendency for adhesives in all fields to be fed automatically to the reservoir receptacle. These units may consist of pumping systems with float valve actuators in the reservoir tray, or fountain-bottle type filling devices, or any of several other automatic filling mechanisms. All of these systems are equally vulnerable to the pitfalls of foaming. Some systems such as continuous pumping arrangements actually encourage the production of stifling foam.

Silicone Defoaming Effect

In Figure 2 we have a graphic illustration of the defoaming effect of a silicone emulsion defoamer on a simple adhesive system. A basic mixture of ninety parts polyvinyl acetate emulsion, eight parts trichloroethylene, and two parts dibutyl phthalate was prepared. To the mixture designated (X) three tenths of a per cent silicone defoamer was added. To the comparison sample designated (Y) no defoamer whatever was added. These samples were placed in graduated cylinders and agitated with a Hamilton-Beach mixer. The time and measure of air entrainment was recorded. The procedure was repeated three times with fresh samples for each series. The defoamed sample (X) entrained a small amount of air initially but the total volume increased very slowly under prolonged agitation. The test series designated (Y) continued to entrain air through the duration of the test. In subsequent runs it was found that the addition of small amounts of paperboard dust aggravated this foaming and acted as a catalyst in this respect.

Resin Foam Potential

The adhesives industry is very aware of the foam potential of resin adhesives. In cooperation with other industries they have developed a series of extremely effective antifoaming agents. These defoamers run the gauntlet from oil-based types to silicones. A large portion of the resin adhesives in production today contain more than merely a single defoaming agent. Many manufacturers may add two or even three separate defoamer types to his adhesive. These defoamers are added not only to control the ultimate foaming properties of the adhesive but also to aid in the manufacture of the product.

Many of the components of today's complex adhesive mixes tend to foam under the complete agitation achieved in the manufacturer's production kettle. In this case these defoamers are selected and added at pre-determined intervals during the production cycle. It has been observed that some defoamers lose their effectiveness under prolonged periods of agitation or mechanical stress. There is little doubt that in particular cases the manufacturer is

forced by the operating standards of some machines to deliberately incorporate additional defoamer or even to change the base type of defoamer being employed.

The author has found the silicone type defoamers to be very reliable and able to withstand long periods of mechanical stress. Other observers may have their own favorite type of defoamer. It is known that many adhesive manufacturers produce their own standard defoamer from a pre-selected mixture of commercial defoaming materials. They endeavor in this instance to take into consideration the many factors of price, stability, solubility, etc., in arriving at their own combination.

During the production of aqueous adhesives some of the formula components tend to foam under the influence of heat and rapid agitation. The addition of defoamers during this phase insures uniform and efficient production.

Vegetable Adhesives

The nuisance of foam is not as prevalent in starch and dextrine based adhesives. It nevertheless poses a serious problem when it occurs. It is true that these adhesives do not foam nearly as much as resin and latex adhesives. In observing this disparity one must bear in mind the inherent differences between colloidal dispersions and emulsions.

The effect of viscosity is sharply felt in considering vegetable adhesive foaming. This is particularly true when viewing inadequately defoamed products that are not only viscous but very tacky and cohesive. An adhesive of this type may begin to entrain air after only a short period of machine operation. This event starts an irreversible chain. As the adhesive entrains air its total solids ratio increases because of evaporation loss. For every five per cent increase in total solids the viscosity of many vegetable adhesives will nearly double in value. The increased viscosity retains the foam segments more securely in its mass and the cycle progresses until the adhesive becomes an unworkable mass or simply foams out of the tray. Predetermination of the adhesive needs as well as sensible machine operation can forestall many of the foaming cases that occur in these type products.

In compounding the typical vegetable adhesive the manufacturer incorporates what he considers to be a safe and reasonable amount of defoamer. He is aware that the over addition of defoaming agents can be as dangerous as their omission entirely. He takes into account the probable length of time that the adhesive will be required to be left in the adhesive tray without replenishment of fresh adhesive. In many instances the writer has observed plants where a packaging machine was allowed to run for hours without any packages passing through the unit. New adhesive was not being added and the material in the tray was being constantly whipped by the agitating action of the machine components. In such instances even the most carefully defoamed products are likely to misbehave. Good adhesive maintenance procedures can prevent this from happening.

There is yet another consequence when an adhesive of this nature is allowed to foam. Foaming, as we have pointed out, is nearly always accompanied by an increase in viscosity. This increased viscosity means that an increased amount of adhesive will be applied to the subject surface. This will result in not only higher operating costs but the bonding time of the adhesive may be noticeably lengthened.

Lowering Foam Resistance

The inclusion of certain mineral extenders, clays, calcium compounds, etc., tend to lower the foam resistance of vegetable adhesives. Some vegetable adhesives contain no specific anti-foaming agents in their formulation. In these cases the manufacturer may be producing a product which his experience has shown does not foam because of the formula characteristics of the ingredients. Because of the price factor affecting the selection of defoamers for these types, the manufacturer must choose carefully. He is necessarily limited to some extent by low ingredient cost. In the selection of defoamers for these types there is a tendency to avoid the more expensive silicone emulsion types and to prefer oil-based or some similar product.

Animal Glue Based Adhesives

Foaming in animal glue may occur at several stages in its route to the consumer. Opportunities are available at the extraction and again at the compounding stages of production. However for this discussion we are primarily concerned with foaming as it occurs in the adhesive consumers' plant.

Separate glues have wide potential as far as foam is concerned. The origin of the glue, its method of extraction, the type of defoamer added during extraction, etc., have a distinct relationship to this potential. Such internal characteristics as the existence of peptones, alkalies, foreign solids, etc., are contributing causes. Today nearly all extractors of animal glue are aware of these factors and take steps to neutralize them. Some of the imported glue finding its way into the country still suffers from inadequate defoaming.

Compounded animal glue introduces two new causes to the foaming dilemma. We must now consider the factors of temperature and bacterial attack as well as such mechanical causes as excess agitation. Animal glue based products, as exemplified by flexible cake cake glue, are usually used at elevated temperatures to insure liquification of the glue jel. These temperature

ranges may be anywhere from 120°F. to 160°F. The temperature at which the products are maintained during use can be a positive factor in determining whether they will foam excessively or not.

At temperatures below 125°F. the glue will tend to thicken and to skin over in the applicator tray. As it thickens the air entrained by the machine components will be trapped beneath the now solidifying surface skin. At this stage the adhesive will become stringy and an even application of adhesive will be difficult to manage.

Most adhesives of this base type operate best at temperatures between 130°F. and 150°F. In the case of particular formulations, notably those containing gum extenders such as carboxymethylcellulose, it may be necessary to operate with the adhesive on the high side of the temperature range.

Host for Bacterial Growth

It must be remembered that animal glue as a protein colloid offers an excellent host for bacterial growth. The adhesive manufacturer incorporates phenol compounds and other substances to render the formula safe from bacterial growth. However excessive prolonged heating at temperatures in excess of 155°F. may render these preservatives impotent.

During such a situation the adhesive will at first thin and then as decomposition begins to take place it may become dark, heavy, and very stringy in machine performance. When such a situation takes place it is best to stop the machine at once. Discard all the adhesive in the reservoir tray and wash the tray and applicator rolls thoroughly. Also scrape the sides of the tray free from any remnants of glue. These pieces may serve to inoculate a fresh batch.

Simple Substances Used

In times gone by glue manufacturers and compounders used simple substances such as lard and grease to act as defoamers. These defoamers lost their effectiveness quickly and were subject to rancidity and other hazards. These defoamers have for the most part been replaced by modern custom tailored defoamers particularly suited to the needs of animal glues.

Summary

In the overwhelming number of instances an adhesive foams because it has been simply beaten into a froth by the action of the machine components acting on it. This situation can be partially aided by the shutdown of these machine components when no adhesive is being consumed in the machine.

Occasionally the addition of extra defoamer by the adhesive producer will be needed to overcome special situations. Such factors as keeping the adhesive level high in the applicator tray or enclosing the tray with a cover will aid in the retardation of foam. The latter suggestion is especially valuable in plants where a measurable amount of dust is likely to enter the reservoir tray.

If an adhesive in your operation seems especially prone to foaming notify your adhesive supplier at once. Although the foaming may not be of such a proportion as to actually cause shutdown of your machine it is nevertheless costing you in terms of adhesive performance. Your adhesive supplier has an arsenal of effective defoamers to work with. Notify him of your observations and your needs. He can help you.

About the Author . . .

E. PATRICK McGUIRE, author of this report on adhesive foaming has had wide experience in the aqueous adhesive field. Educated at Upsala College and Rutgers University, Mr. McGuire has served on the research staffs of National Starch Products, Inc., and Swift & Co. He is presently affiliated with United Paste & Glue, Inc. in New York. Mr. McGuire has authored several other reports on such subjects as aqueous adhesives.

Bonding Transparent Packages

Plastic Films Require Unique Adhesives

The rapidly expanding family of plastic films—cellophane, acetate, vinyl, polyethylene, Saran, pliofilm, Mylar, nlyon, and others—used for modern see-through packages—has challenged the adhesives industry to provide products for properly bonding all the materials in this complex array.

A short time ago, the converter or packager who manufactured bags overwraps, window boxes, etc., from transparent films often found himself without the proper adhesive when he changed from one film or package design to another. In many cases, he had to turn to sources other than adhesive suppliers to get the required product.

The confusing problem of widespread sources for plastic film adhesives has now been largely overcome, according to Mortimer E. Stern, Director of Technical Market Development for Morningstar-Paisley, Inc. Mr. Stern states that "Leaders in the adhesives industry have kept pace with technology in the plastics and packaging machinery fields by developing a line of adhesives that fills the requirements of all transparent films.

"Recognizing the serious responsibility placed on the users of plastic films, adhesives manufacturers quickly instituted intense research and development programs to provide adhesives that possess specialized characteristics—such as freedom from odor, toxicity, and mold formation, as well as heat and moisture stability, and controlled vapor transmission. Finally, end-use tests in the adhesives laboratories indicated which product fulfilled the users' needs.

"At Morningstar-Paisley, a vast change has taken place over the past five years. Today we produce over 300 adhesives specifically formulated for transparent films to satisfy the wide range of performance demands, compared with less than 50 products available five years ago for these materials."

To further help the plastic film user with his problem, the Scientific Adhesive Service of Morningstar-Paisley, Inc., has developed a "Guide to Adhesives For Transparent Films and Characteristics of Transparent Film Adhesives." The table lists popular types of transparent films and suggests the types of adhesives applicable for a number of uses, such as transparent bags, window bags, window boxes, or laminations. The adhesives listed in the table can be used with any of the existing machines normally used by converters. Constantly improved, today's adhesives can be applied with cleanliness on machines, and provide faster setting, stronger bonds with superior aging properties. Each adhesive is engineered to meet a specific end use. In addition, many of these adhesives have multi-use functions and will work well with two or more different films.

Characteristics of Transparent Film Adhesives

Resin Adhesives—Products based on polyvinyl acetate and its copolymers. They are water based emulsion adhesives generally containing plasticizers, with or without solvents. Usually, they may be diluted with water and machine clean-up accomplished with water. Their machining characteristics are generally good.

Latex Adhesives—Water dispersions of natural rubber, synthetic rubber, or related polymers. They are generally alkaline. Latex adhesives are usually modified with resinous tackifiers, plasticizers, with or without solvents. Their machining characteristics are, on the average, not as good as resin adhesives.

Solvent Cements—Available in two types: solvent activators, which are used to enhance heat sealing characteristics; and lacquer adhesives, which consist of adhesive polymers dissolved in organic solvents. Both types are non-aqueous in nature, and clean-up requires organic solvents. Dilution is made with special organic thinners.

Vegetable Base Adhesives—Water solutions of starches, dextrine, or natural gums. Water is used for dilution and clean-up. They have excellent machining characteristics, and are generally used on plain cellophane. They have very poor adhesion to other types of plastic films.

Hot Melts—Solid adhesives, usually of a synthetic polymeric nature, which must be melted and used at elevated temperatures to obtain adhesive characteristics. Gluing equipment normally requires special modification to attain the heat necessary to apply these adhesives. Clean-up is accomplished with organic solvents. In applications on transparent films, the heat necessary to apply hot melts is so high that most plastic films become distorted or degraded. For this reason, although they may have application in special cases, hot melts are not included in the attached table.

Heat Seal—Adhesive films which are applied to paper, plastic films, foil, etc. and dried. The adhesive bond is obtained by activating with heat. Examples of heat seal applications include heat seal labels, heat seal bag headers, etc. Adhesives used to lay down these films may be resins, latices, solvent cements, or hot melts. For recommendations on specific operations, it is suggested that the plastic film user contact his adhesive supplier or label manufacturer.

A Comparison of

Tack Testing Methods for Pressure-Sensitive tape

By FRANKLIN S. C. CHANG
Mystik Adhesive Products, Inc., Northfield, Illinois

Mentions of tack of pressure-sensitive tape are frequently made in published works and methods for its measurements are suggested from time to time (5,6,8). But. somehow, the term tack is not clearly defined. It is occasionally used in the same sense as that which is now defined as adhesion strength in ASTM Standard D-1000. On other occasions, methods have been designed to measure tack without first making clear what was measured. Other terms, such as quick tack, quick grab, instant tack, quick stick and so on, are also used to designate this characteristic of pressure-sensitive tape.

To make the confusion worse, tack is used to mean the ability of rubber to adhere to itself or to adherends of different nature, while the same word means the resistance to cohesive break for printing ink. For paint and varnish it is usually the adhesion feeling to the finger. In the case of pressure-sensitive tape, the practice now seems well established that adhesion strength is the peeling resistance measured by the ASTM D-1000 standard method, while tack is the adhering property of pressure-sensitive tape under conditions different to that of adhesion strength.

Several authors (5,7) suggest that tack of pressure-sensitive tape is to be defined as peeling resistance, under small pressure after application, with or without a limitation of contact time. In a previous paper, (2) this author suggested that tack of pressure-sensitive tape be defined as the peeling resistance under the weight of the tape itself at a definite peeling speed and reported that the tack thus measured is distinctly different to adhesion strength according to ASTMD-1000, even though the testing method is not radically dissimilar to that for adhesion strength.

Wide interest and discussions followed that paper, most of which were concerned with the correlation between this tack measurement method and the results obtained by methods already in use in individual laboratories. The Pressure-Sensitive Tape Council is conducting an extensive study of this suggested method. The purpose of the investigation is to compare different tack measuring methods for pressure-sensitive tape, which are known to this author at the present time.

From a large number of testing methods for tack of pressure-sensitive tape suggested, the following five were selected to represent the main categories:

(1) Chang method, peeling tape from a flat steel panel;
(2) Rotating surface method, peeling tape from a rotating steel cylinder;
(3) Inclined plane method;
(4) Douglas curved track method, and
(5) Hercules probe method.

The first method was suggested by the author previously in his first paper, and designated by the Pressure-Sensitive Tape Council as the Chang method. For its shortness, this name is retained in this paper. This and the second method belong to the same category, involving the use of a tensile testing machine to separate the tape from a standard adherend surface at a definite rate. The pulling force required is used as a measure of tack. Usually the tape is clamped and the adherend is pulled. The third and fourth methods belong to a second category, in which a steel ball is rolled over a stationary adhesive surface. Tack is indicated by the distance over which the ball rolls. The last method employs a carefully machined brass probe from which the adhesive surface is pulled away under controlled conditions. These methods will be discussed in detail after a general discussion of the process of peeling pressure-sensitive tape.

Details of Tape Peeling

The adhesive on a pressure-sensitive tape is not always a smooth, flat film. When the tape is applied onto an adherend with no foreign pressure on the backing, the adhesive film usually makes contact with the adherend surface on spots, but not on the whole surface. If pressure is then applied to the backing, either by finger or mechanical device, the contact area between adhesive and adherend is increased.

When the tape is peeled away from the adherend, the backing is bent. The extent of bending depends on the manner in which the peeling is carried out. The bending of the backing presses the adhesive down toward the adherend, and increases the contact between adhesive and adherend. In the meantime, the ad-

Note: Presented before the 74th meeting, Division of Rubber Chemistry, ACS, Chicago, Illinois, September, 1958.

hesive film is broken up into tiny "strings" and each string is stretched. This phenomenon is readily observed under a low power microscope. Figure 1 is a schematic reproduction of the picture, in which 90° peeling is used as an example. But the general discussion holds for all cases of peeling with slight modification.

In the process of stretching, each individual string is subjected to three forces: the stretching force in the string and two adhesion forces, one between the adhesive string and the backing, and the other between the string and the adherend. As the peeling advances, the strings which are already under strain are stretched further and further, till the maximum of stretching is reached. This maximum is dictated by one of the three forces.

When the weakest link of the three is the adhesion force to backing, the string detaches from the backing. If the stretching force which a string can sustain at its maximal elongation is the smallest of the trio, the string breaks cohesively. In both cases it is said the tape leaves "residue," since some of the adhesive mass is left on the adherend. That is undesirable in the performance of a pressure-sensitive tape.

Adhesion Force and Stretching

The normal case for a usable tape is that the adhesion force to adherend is exceeded by both the stretching force in the string and the adhesion force to backing. In this case the string would detach from the adherend and snap back to the backing. Hence, in the normal case, the adhesion force between string and adherend is the limiting factor to the extent of elongation of the string.

When the first layer of strings reaches the maximum elongation allowed, a state is attained in which a number of the longest strings are breaking at one side of the nib, (point *b* in Figure 1) while coming into this region is another group of new strings at the side *a*. The situation would be a steady state, if the number of strained strings in the nib is very large and the stretching force in the breaking strings is relatively small compared to the total peeling force. This is evidently not the case.

However, one can substitute for the true situation a state of affairs wherein the nib is stationary, with its vertex fixed at point *a*, and the backing of the tape and the adherend passing along its two sides. Its third side advances to the right when the strings are developing, and recedes to the left when the longest strings are broken. However, at every instant the peeling force required to pull the tape away from the adherend is balanced by the stretching forces in the strings. The peeling resistance is the vectorial sum of the stretching forces in all the strings —vectorial because the stretching forces are not necesarily in the same direction of the peeling force.

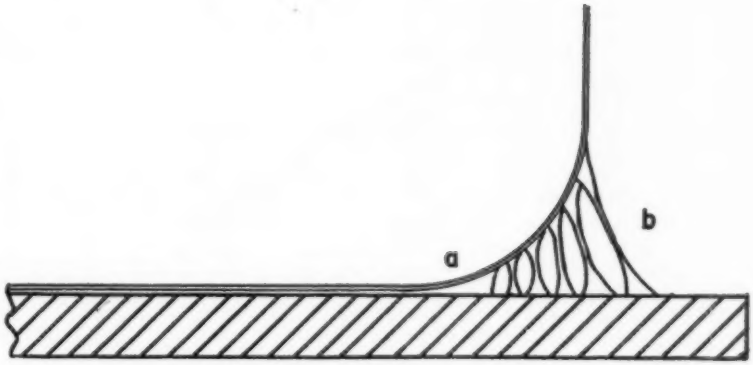

FIG. 1—90° peeling of pressure-sensitive tape

Since the distribution of strings over the tape is random and the number of strings in the nib is large enough, the vectorial summation can be approximated by an integral in the form of $\int wnfdL$, where w is the width of tape, L the length of tape under strain, n the number of strings per unit area of tape surface, and f the contribution to peeling resistance of an individual string. Although the present stage of knowledge about adhesive rheology does not allow a quantitative expression of the force f as a function of L to be exact, a qualitative discussion of the integral will lead to some interesting results.

The width w and the number n of strings per unit area can be taken as constants. The stretching force is a function of elongation and time rate of elongation of the individual string. The same holds for f. However, f is limited by the magnitude of the adhesion force between string and adherend. In the 90° peeling case as illustrated in Figure 1, for example, when f exceeds this force the string detaches from the adherend and contributes no more to peeling resistance. Hence the adhesion force between string and adherend limits the maximum length to which a string can be stretched before detaching. This maximum length of string in turn determines the length of tape under strain, L. Thus, the adhesion force between string and adherend determines the magnitude of peeling resistance.

At the start of peeling, the peeling resistance increases rapidly as the number of strings increases. When some strings are brought to the maximum length permitted by the circumstances, the peeling resistance will reach its maximum. The peeling resistance will drop to its minimum when the strings of maximum length break, and it will oscillate between the maximum and minimum until the end of the peeling process. The extent of fluctuation depends on how much of the stress is sustained by the strings of maximum length. When the peeling is done at constant peeling rate, the peeling force will fluctuate. The peeling rate will vary from time to time in the case of peeling with constant force.

Applied Pressure Factor

As any pressure applied on the backing after the pressure-sensitive tape is put on the adherend would increase the adhesion between string and adherend, the peeling resistance or the peeling force required would be increased by the applied pressure, when the peeling rate is kept constant. From this analysis it is clear that attention must be paid to the factor of applied pressure in a comparison of peeling methods.

It is a well-known fact that the viscous flow property of adhesive makes the stretching force increase with the stretching rate. Here, distinction should be made between peeling rate of tape from adherend and stretching rate of strings. In the case of 90° peeling shown in Figure

1, for instance, the peeling rate is the rate of tape length peeled from the adherend, while the stretching rate of strings depends on the peeling rate and the position of the string in the nib. To be more specific, the stretching rate of the string is a function of the shape of the curve formed by the backing material. The distance from the root of the string to the vertex *a* of the nib, and the rate of peeling, i.e., the rate of motion of backing material.

Since the stretching force in the string is limited by the adhesion force between string and adherend an increase in stretching rate would not increase the adhesion force, it seems that the peeling resistance would not increase with an increase in peeling rate. However, the detachment of the string from the adherend is not instantaneous when the stretching force reaches the adhesion force. It takes a short duration of time. This delay, due to the flow property of the adhesive, renders the string stay longer than it would were the detaching instantaneous. Consequently a larger peeling force is required to separate the tape from adherend at higher peeling rate. However, when the peeling rate is very large, the peeling force approaches a limiting value.

In summary, the dominating factor in the peeling of pressure-sensitive tape is the adhesion force between string and adherend. The measured peeling resistance is not this adhesion force, but a vectorial sum of stretching force in strings with the adhesion force to adherend as the limiting value of this stretching force. Therefore, the force required to separate a tape from an adherend is a function of the intrinsic factors of the tape, such as rheological properties of adhesive used, thickness of adhesive film, surface condition of adhesive, and stiffness of backing material, together with arbitrary conditions, like the nature of adherend, pressure applied after application, peeling rate, peeling angle, and ambient temperature.

Chang Method

In this method the tape is to be put on a stainless steel panel, with no other pressure than the weight of the tape itself. The contact between the adhesive and the testing panel is kept to the lowest possible minimum and made characteristic to the tape. The peeling is done with the free end of the tape at an angle of 90° to the adherend and the testing panel is made to move at a speed equal to the peeling rate, 12 inches per minute. The panel holder to tensile testing machine for this purpose is schematically shown in Figure 2.

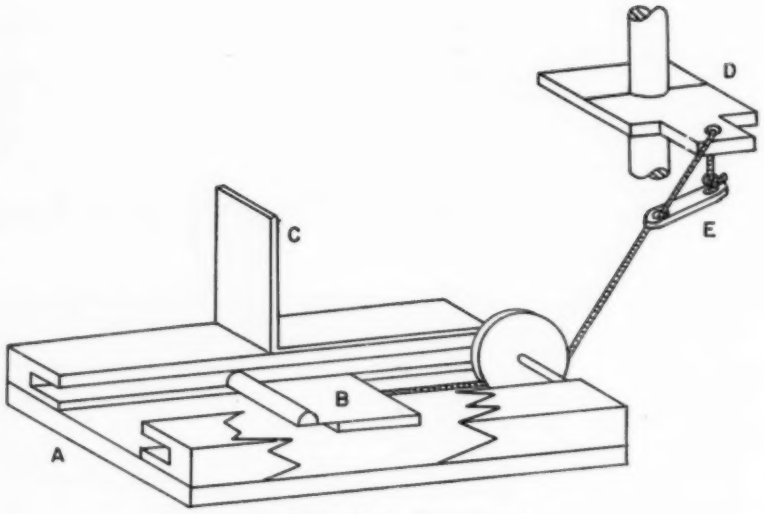

FIG. 2—Panel holder for Chang method

The panel holder *A*, which is attached to the platen of the tester in place of the lower clamp, provides the sliding grooves for the testing panel to move along the horizontal direction. The panel is pushed at the required speed by the small pushing platen *B*, which is placed under the panel with the button in contact with the end of the panel. The clamp *D* and adjusting plate *E* are connected with the pushing platen *B* by a string which is threaded through the under side of the small pulley on the panel holder *A*. With clamp *D* affixed on one of the supporting columns, the angle between the free end of the tape and the upper surface of the panel can be adjusted by moving the plate *E* up and down with the straight angle *C* as a guide, which is fixed on the edge of the panel holder *A*.

The experimental procedure and the various influencing factors of this method have been discussed in the first paper and need not be repeated here. A summary of the conclusions will be included for the completeness of this work. The method was found to be simple and precise enough for practical purposes. Tack obtained by this method is definitely distinct to ASTM D-1000 adhesive strength of the same tape. The difference is due to difference in the pressure applied rather than in the peeling angles alone. The stiffness of backing material has much less effect on tack thus measured than on adhesion strength.

Tack increases with amount of adhesive used, i.e., the thickness of adhesive film on the tape, in the same manner as adhesion strength does. This is understandable in the light of the fact that, when the elongation is the same, the thicker the adhesive film to start with, the longer the final length of the string at breaking. When the breaking length is larger, the number of strings under stretch would be larger. The effect of peeling rate on tack is shown in Figure 3, by plotting tack measured semi-logarithmically against peeling rate. It is obvious that a straight line can be used to represent the relation.

The practical advantage of this method is this. In the actual application of pressure-sensitive tape, the user may or may not apply pressure on the backing. It would be of interest to the manufacturer or designer of tape to find the performance of his tape in both conditions, namely, applied with and without pressure. Adhesion strength according to ASTM D-1000 supplies the information under the former condition, while tack gives that under the latter condition. It occurred in this author's experience that two production lots of the same tape gave the same adhesion strength, but different tack readings, and that the one with lower tack caused complaints.

Rotating Surface Method

This author was informed that a tack tester with a rotating surface is used by one pressure-sensitive tape manufacturer. An improvised attachment was employed to provide a roller with a diameter of 1¼ inch as a rotating surface. One end of

the tape to be tested was clamped in the upper jaw and the other end was let down slowly to make contact with the roller. The same rate of peeling was used for the purpose of comparing the results with that obtained from the Chang method.

The case of peeling from a rotating surface is not quite different from that in the Chang method, except that the nib formed by the strings of adhesive under strain is limited by two curved sides, instead of one as in the Chang method. Naturally this would have changed the rate of stretching and elongation of the strings. However, one would expect a definite relation between the results from these two methods. This is verified by the experimental results of assorted pressure-sensitive tape samples, which are shown in Figure 4 by plotting tack on rotating surface against that by the Chang method.

A straight line is fitted to the data by the least square method. The adjusted correlation factor of these two sets of data is 0.96, which shows that the results from the two methods are directly proportional to each other. One may consider the two methods as the same in nature.

Inclined Plane Method

This is one of the two rolling ball methods discussed in this paper. In this method, a steel ball rolls down over an adhesive surface with an inclination of 30°. The rolling distance is taken as a measure of tack. Mention was made about this method in the previous paper, where it was pointed out that no results of any significance were obtained using a ¼" ball. Dow (3) suggested a releasing distance of 4 inches, and the size of the largest ball retained within 4 inches of adhesive surface is used as indication of tack.

When a spherical object rolls over an adhesive surface, the ball presses down on the adhesive and the tiny masses of adhesive adhere to the surface of the ball. If the total adhesion force is not enough to stop the ball instantly, the ball rolls forward and strings are formed between the ball surface and the tape. The situation would not be changed if one imagines the center of the ball as fixed, and the tape moving across the surface of the ball. Therefore, the case of inclined-plane-and-rolling ball is similar in nature to that of peeling tape from a cylindrical adherend. However, the similarity stops there.

The nearly free fall sets the ball moving at a high velocity at the moment of meeting the adhesive surface. The retarding force offered by the strings of adhesive slows down the motion of the ball. Eventually the ball comes to a stop. Thus the peeling speed in this case changes with time or rolling distance. In short, this inclined plane method is a case of varying peeling rate, while the methods discussed above are at constant peeling rate.

It has been noted in the foregoing paragraphs that the tack and adhesion strength of tape changes with the peeling rate and that there seems to be a limiting value when the peeling rate is very high. Therefore, the retarding force offered by the strings of adhesive in this case would be this limiting value. A rough, simple calculation will show that the peeling rate at the beginning of retardation is in the order of magnitude of $10^{(3)}$ inches per minute, which is far beyond the capacity of an ordinary pulling machine.

When the ball is rolling over the adhesive surface at such a high velocity, it takes quite a while to slow down to the low velocity region encountered on any pulling ma-

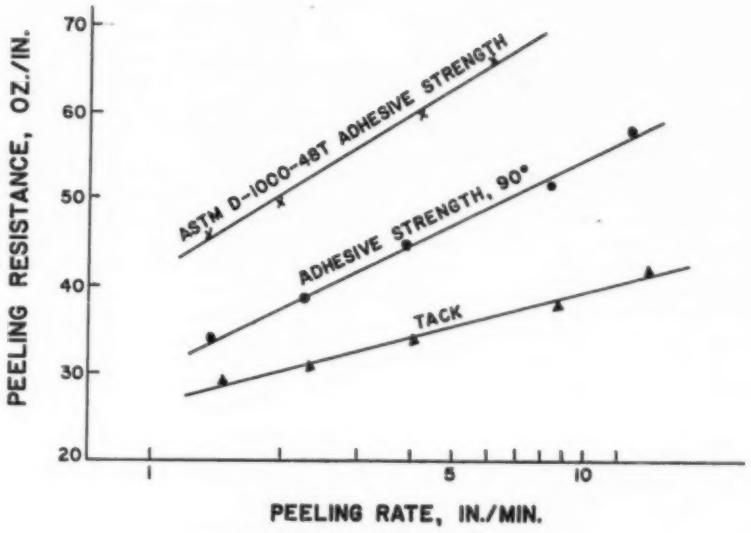

FIG. 3—Tack versus peeling rate

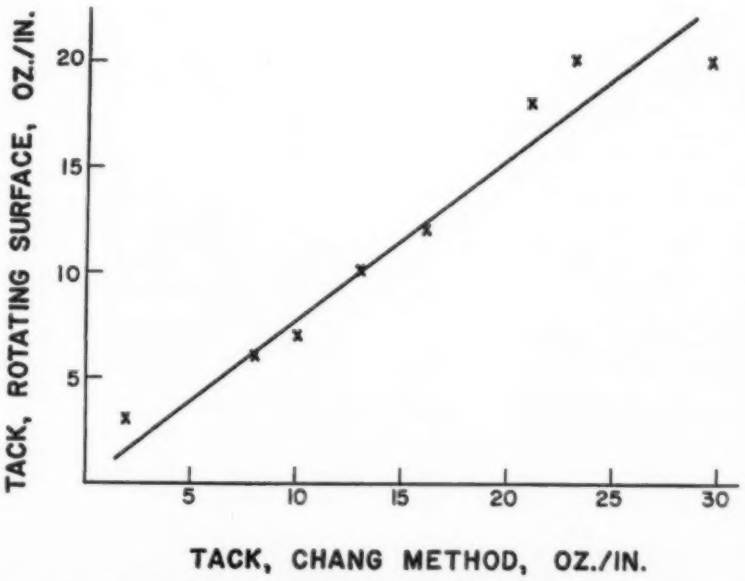

FIG. 4—Comparison of rotating surface and plane surface methods

chine. That is to say, over a large part of the rolling distance the retarding force can be taken at the limiting value. Since the retarding force follows a logarithmic function of the peeling rate, one can assume that the distance rolled by the ball at low velocity is negligible compared to that covered at high velocity. In other words, the retarding force over the whole rolling distance can be approximately taken as constant at a certain limiting value. This assumption proves to be in agreement with experimental results. The following equation for an inclined plane with 30° inclination can be derived readily:

$$P = (1 + d/D)W/2$$

where P is the retarding force, d and D are the releasing and rolling distances respectively, and W the weight of the ball used. Let the ratio of contact area between the adhesive and the ball to the surface area of the ball be a and the average retarding force per unit area p, then

$$K_I = 3ap/s = r(1+d/D)/2$$

where s is the density and r the radius of the ball. The quantity K_1 would be characteristic to the tape only, were it constant to r.

In this investigation an aluminum track of 30° inclination was used. The tape to be tested was put adhesive face up on a length of double-face tape which was laid down on the track to reduce slipping. The upper part of the tape was covered by a length of glassine paper. The stainless steel ball was released from a predetermined distance from the exposed part of the tape in question. Hereafter, this is referred to as the "releasing distance."

It was observed in actual operation that with large balls the ball slows down at first, then comes to a temporary stop and starts to roll down the adhesive surface again at a slow speed. This is probably due to the relaxation phenomenon of the adhesive strings. As the ball comes to a stop and time goes on, the strings are relaxed and the retarding force is reduced somewhat to an extent that the ball weight overcomes the retarding force and the ball starts to roll again. Evidently when this will happen depends on the ball weight and the property of the adhesive.

When the ball is large enough, the stop will likely be for only a very short moment. Therefore, the testing with a large ball should be handled with care. The rolling distance obtained with a small size ball, on the other hand, is rather short. Limited by the low precision of visual observation, ⅛ inch at best, the readings taken with smaller balls are not as precise percentagewise as those obtained with larger balls. Thus in this experiment the size of ball used was so chosen that it is small enough to avoid difficulty in determining the rolling distance on one hand and large enough to make this distance larger than one inch so as to assure 10% precision in the resulting reading.

It was also found that the standard deviation of rolling distance is about 15 per cent. In order to obtain representative data, three readings were taken on each length of sample tape and the average of nine readings was used as the average rolling distance D in Table I which is compiled to test the first equation.

Table I—Test for Constancy of d/D

Sample No.	Weight of ball, W g.	Releasing distance, d in.	Ave. rolling distance, D in.	d/D ave.	K_I ave. in.
1	66.8	4	3.7	1.1	.54
		8	5.3	1.5	
		12	8.2	1.5	
	44.7	4	2.1	1.9	
		8	4.5	1.8	.49
		12	6.7	1.8	
	27.1	4	1.0	—	
		8	2.4	3.3	.76
		12	3.5	3.4	
2	27.1	4	2.9	1.4	
		8	8.5	0.9	.36
		12	11.8	1.0	
	16.3	4	1.9	2.1	
		8	4.8	1.7	.41
		12	6.3	1.9	
		4	1.2	3.3	
	8.3	8	2.8	2.9	.48
		12	3.8	3.2	
3	93.8	4	2.2	1.8	
		8	4.9	1.6	.72
		12	6.7	1.8	
	55.0	4	1.1	3.6	
		8	2.3	3.5	.94
		12	4.5	2.7	
	35.8	8	1.8	4.5	
		12	4.1	2.9	.88
	21.7	8	1.4	5.7	
		12	3.1	3.9	.91

Rolling and Releasing Data

It can be noticed from Table I that generally the rolling distance is directly proportional to the releasing distance. When the size of the ball is held constant, the ratio d/D remains almost constant, even though the releasing distance has been increased three times. Since constant d/D means constant P, according to the first equation, this shows that the retarding force is independent of the releasing distance d, hence, to the velocity of the ball immediately before hitting the adhesive surface. This holds at least in the region of velocity covered in this experiment.

In order to compare the inclined plane method and the Douglas method (discussed in the next section) with the Chang method, eleven tape samples were tested by all three methods at the same time. The specimens were taken from the same roll of samples. Every third specimen was used for each method so that any variation in sample would be evenly distributed in all three sets of results. The results from the inclined plane method are listed in Table II along with the tack values obtained by the Chang method. The releasing distance used was 4 inches. Balls of four sizes were employed, with each of which six readings from two strips of samples were taken.

Due to the small number of readings taken, the 95% confidence interval of K_I is plus-or-minus 10% in some cases. In spite of this, it can be noticed in Table II that sample numbers 8 and 14 give higher values of K_I in the flat paper

Table II—Comparison Between Inclined Plane and Chang Methods

Sample No.	Average k_I in.				Tack oz./in.
	2r*	19	25	30	34	
Paper, flat						
4		.58	.49	.42	.41	11
5		.56	.49	.42	.42	10
6		.70	.58	.53	.52	11
7		—	.60	.58	.55	12
8		—	.69	.65	.63	16
Paper, crepe						
9		.40	.30	—	—	3
10		.70	.58	.53	.57	8
11		.70	.63	.65	.67	9
Cloth						
12		.70	.63	.58	.55	10
13		.70	.64	.59	.55	14
14		—	.82	.74	.75	29

* Diameter of ball in 1/32 in.

Table III—Comparison Between Douglas and Chang Methods

Sample No.	Average k_D in.				Tack oz./in.
	2r*	19	25	30	34	
Paper, flat						
4		.68	.63	.61	.54	11
5		.75	.66	.68	.67	10
6		.70	.69	.66	.63	11
7		.83	.72	.72	.69	12
8		.95	.82	.84	.86	16
Paper, crepe						
9		.45	.43	.39	.35	3
10		.69	.40	.45	.50	8
11		.81	.85	.85	.75	9
Cloth						
12		.73	.76	.74	.71	10
13		.74	.68	.67	.64	14
14		.72	.66	.68	.76	29

* Diameter of ball in 1/32 in.

tape group and cloth tape group respectively, while the value of K_I of sample No. 9 is lower than those of the other two samples in the crepe paper tape group. The rest of the samples give almost the same values of K_I. Tack values by the Chang method result in the same comparison.

However, the average values of K_I of sample No. 8 and 11 are practically equal, while the tack value of sample No. 8 is almost twice that of sample No. 11. Furthermore, sample No. 14 gives a K_I slightly higher than that of sample No. 11, but the tack value is three times greater. These discrepancies are probably due to the striking difference in peeling speeds involved in these two methods. Therefore, although the same general trend appears in the two sets of data, there seems no quantitative correlation between them.

When $d = D$ in Equation II, $r = K_I$. This is the basis for using the size of ball retained within *D* as a measure of tack, as mentioned by Dow(3). In spite of the slight increase in K_I when the radius of the ball decreases, the high standard deviation will not allow a choice of the size of ball as close as 1/32 inch in diameter. In addition, it is possible for a smaller ball to roll over a distance larger than one that is larger in size. In other words, a larger ball may at times be retained within D, while a smaller ball may not. This may be the reason that Dow(4) had indeed found that the results do sometimes show large deviation.

This method is likely to be useful for measuring the limit of the retarding force of pressure-sensitive tape when means are provided to measure rolling and releasing distance to high precision and to have the tape specimen stay put on the track. Nevertheless, the large number of tests dictated by the high standard deviation in results, if not improved, will reduce the possibility of using this method as a production control.

Douglas Curved Track Method

The track used in this method is curved at one end. The pressure-sensitive tape to be tested is to be threaded through a slot at the bottom of the curved part of the track and locked in position at the back. Adjoined to the curved part is a leveled part, over which the tape is extended and locked at the other end with a mechanical device, with which the tension in the tape is supposed to be adjustable.

On the curved part several releasing positions are provided for the 1¼ inch stainless steel ball. The distance on the tape, over which the ball rolls, is read on a ruler attached alongside the leveled part of the track. The ratio of the releasing height to the rolling distance is supposedly to be taken as a measure of tack of the tape.

This tester differs from the inclined plane tester in two ways: First, the ball rolls on a curved track at the start and hits the adhesive surface at the bottom of the curved part. Secondly, the tape lies horizontally on the tester, instead of making an angle. Nevertheless, they are based on the same principle, namely, using the retardation to the motion offered a spherical object by the tape in question as the measure of tack.

Hence, what was said about the inclined plane tester is also applicable in this case. Here, the first equation assumes a simpler form, i.e., $P = HW/D$, where H is the releasing height. The other symbols have the same meaning as previously. Since this method is very similar in nature to the inclined plane method, it is only reasonable to expect $K_D = 3ap/s = rH/D$. Theoretically K_D should be identical to K_I.

It was found in actual operation that the tape did not always stay in place but was pushed along by the ball. This fact might cause a great inconsistency in the resulting rolling distance, to which two other factors may contribute: First, the thickness of tape varies. The adhesive surface is not always on the same level as the bottom of the curved part of the track. When the ball comes down to the slot it hits the tape and jumps up onto the adhesive surface. This small jump slows down the motion of the ball somewhat.

Secondly, the ball does not always go straight and sometimes hits the side of the track. In our experiment a double faced tape was laid down on the track first and then the roll of tape in question was unwound slowly by rolling on the double faced tape. This operation prevented the tape from being pushed along by the

ball. Whenever the ball hit the side of the track the reading was discarded and the experiment was repeated.

The same practice used for the inclined plane method was applied to this experiment, namely, three readings were taken from one specimen and the mean of the six readings were used for the correlation. Shown in Table III are the results obtained, for which various sizes of ball were used including the 1¼ inch one originally suggesed (W = 93.8 g.).

As can be seen in Table III, the value for K_D is generally higher than the constant K_I obtained by the inclined plane method. The main cause of this unexpected result is probably the bump caused by the difference in levels of the adhesive surface and the bottom of the curved part of the track. When the ball hits the bump, part of the kinetic energy is absorbed, so that the apparent retarding force shown by the tape is higher than it actually is. The extent of this effect depends on the thickness of the sample tape in question, which varies from one tape to the other.

The comparison of this method with the Chang method gives the same result as that obtained from the inclined method. Therefore, one can take the Douglas method as a modification of the inclined plane method yielding a larger rolling distance, and, thus, a narrower 95% confidence interval. Improvement on the experimental control is also necessary in this method.

Hercules Probe Method

Wetzel suggested(7) the use of a carefully machined 1/16-inch brass probe to measure the tack of pressure-sensitive adhesive film deposited on glass. The film approaches and contacts the probe at 20 inches per minute, and moves away from the probe at the same speed after a contact time of 1 second. The pressure applied is equivalent to 7 psi. The pulling is done with an Instron tensile testing machine and a Sanborn high speed recorder is used for recording the load on the probe. The average of ten readings of the stress required to break the interfacial bond between adherend and adhesive is taken as tack.

Neglecting the possible irregularity at the edge of the probe, the peeling from the probe is a case of peeling from a flat circular surface. The strings in this case occupy a cylindrical volume, instead of the curved nib in the above discussed cases. The stretching rate of the strings is equal to the peeling rate. When the stress is taken at the interfacial breaking, the elongation is at its maximum value. The integral $\int nwfdL$ takes a simple form as nfA, where A is the area of the adherend and f the stretching force in the string, equal to the adhesion force between adhesive and adherend. It would seem possible to use this method to measure directly the adhesion force between adhesive string and adherend. However, this will be possible only in the case when the anchoring ends of adhesive strings remain in a plane parallel to the surface of the probe.

This condition is fulfilled when the adhesive film is deposited on a solid surface, such as a glass panel in Dr. Wetzel's work, and, thus the adhesion force between the adhesive string and the supporting panel is high. In the case of pressure-sensitive tape the backing material will not remain flat. It would be highly improbable, if not impossible, to reproduce the adhesive film of tape on a supporting solid, especially in the case of partially vulcanized film.

When this method is applied to pressure-sensitive tape, with no provision to keep the backing flat, the backing material deforms and the case is a nib of special shape, namely, a cylinder with a flat surface at its top and a curved surface at its base.

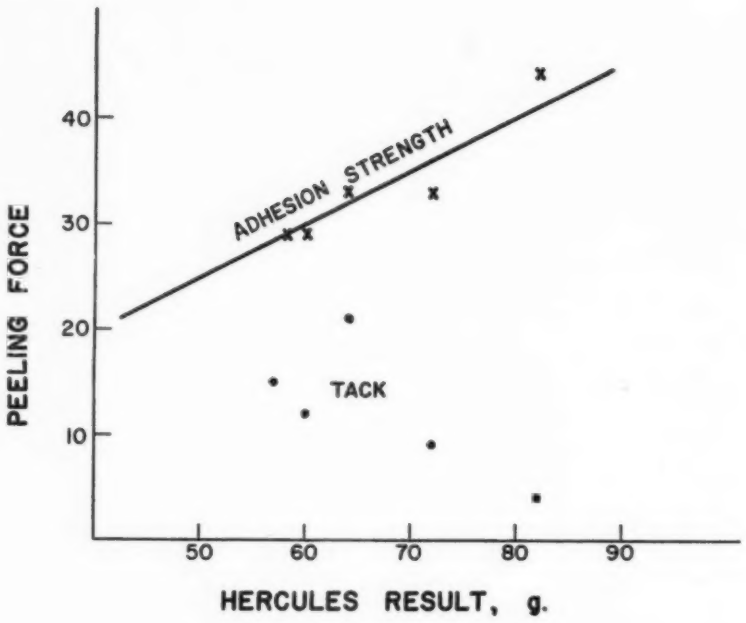

FIG. 5—ASTM D-1000 and Hercules method

Wetzel found(7) that results by the probe method increase rather sharply and linearly as contact time increases from 0 to approximately 10 seconds and less rapidly from 10 to 20 seconds and constant from 30 seconds up. Bright(1) reported observation of increase in adhesion strength with contact time. In our experience with adhesion strength and tack by the Chang method, no appreciable increase was found from 30 seconds to 5 minutes of contact time. This difference may perhaps be accounted for by the fact that the contact time in our experiment is beyond 30 seconds and the film is partially vulcanized.

ASTM and Hercules Method

The results obtained with Mystik tape samples by the Chang method and the Hercules method through the cooperation of Dr. Wetzel are shown in Figure 5. Here the tack and adhesion strength are plotted against the results of the same samples by the Hercules method. The Hercules readings of all samples are numerically twice as much as the corresponding adhesive strength. The adjusted correlation factor between these two sets of results is 0.95. Between the Hercules results and the tack values derived by the Chang method there seems no correlation.

The good correlation between the Hercules results and adhesion

strength is not surprising when the effect of the pressure used is taken into consideration. The pressure in the Hercules method is about 7 psi., (7) while in the case of adhesion strength it is about 19 psi. and zero in the Chang method. Hence, it is safe to conclude that the Hercules method, when applied to pressure-sensitive tape, is closer to the adhesion strength method than to the Chang method.

Conclusions

Since peeling resistance of pressure-sensitive tape is determined by a group of intrinsic and arbitrary factors, comparison of testing methods for tack should be based on consideration of these factors. On this basis, the peeling methods with plane adherend and cylindrical adherend with no foreign pressure applied are the same. The rolling ball method, inclined plane or curved track, operating at relatively high peeling rate, probably measure the upper limit of the resisting force. The result of the Hercules probe method is very close in nature to ASTM D-1000 adhesion strength, when applied to pressure-sensitive tape.

For quality control, the most convenient are the peeling methods. The large number of test readings required by the other methods to obtain representative data reduces their possibility for use in production control.

Acknowledgement

The author wishes to express his appreciation to Mystik Adhesive Products, Inc. for permission to publish this work, and to Dr. F. H. Wetzel, of Hercules Powder Company for his cooperation in the experimental work with the Hercules method.

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About the Author . . .

FRANKLIN S. C. CHANG graduated from National Institute of Technology, China, (B.S.) in 1938. He came to the U. S. in 1947 for advanced study after competing in a Chinese-government-sponsored examination. Mr. Chang completed work for M.S. in chemical engineering at Purdue University in 1949. After obtaining his Ph.D. degree in 1952, he joined Mystik Adhesive Products, Inc.

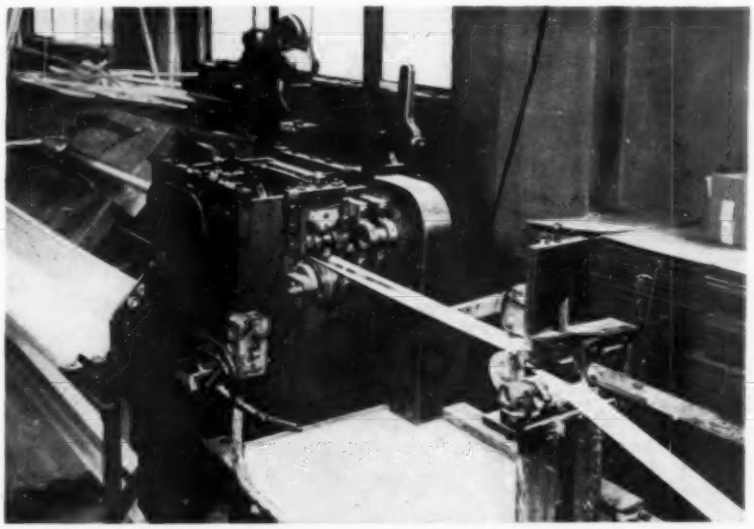
Bonding Paper-to-Metal — *Automatically*

The use of a rapid drying, short tack range adhesive made by the Adhesives, Coatings & Sealers Division, Minnesota Mining & Mfg. Co., Detroit, Mich., is said to help make possible the automatic process of bonding paper to formed aluminum strips in the production of corner beads for dry wall construction at Beadex Corp., Seattle, Wash. The corner beads consist of an aluminum strip formed to an angle of 90° and faced with an adhesive bonded paper. Machine production rate is approximately 5700 fph.

To begin automatic bonding operations, a roll of flat aluminum strip is drawn into guide rails. The continuous strip then passes through a detergent solution and hot water bath. After air drying, the strip is drawn through seven rolls which form it into a 90° angle channel.

The adhesive, designated as EC-1099, is automatically applied to the paper by a special applicator. The roll of paper is first cleaned of excess lint and fuzz by means of a scraper and vacuum nozzle. The paper strip then passes under an adhesive applicator, which deposits a uniform film of adhesive on the paper. The adhesive-coated paper is then guided through a series of pulleys until the adhesive has become sufficiently dry for proper bonding.

As the formed channel proceeds through the machine, it is combined in a forming roll with the adhesive coated paper. The paper and aluminum assembly are then drawn through a second series of rolls which bond and form the paper to the "V" shaped channel and cut the finished strip to predetermined lengths.



Automated bonding of adhesive coated paper to a "V" shaped aluminum strip.

Bulk Handling Systems Facilitate

Adhesive Powder Handling

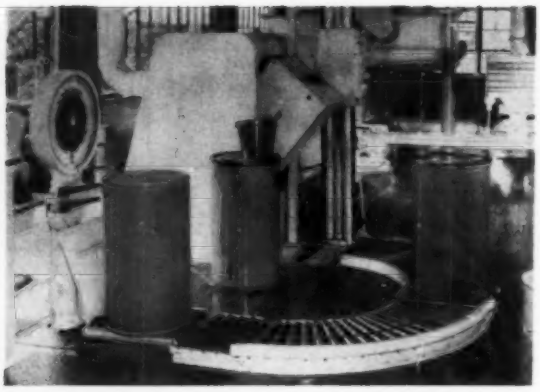


FIG. 1—Dump bin introduces adhesive ingredients into screw conveyor which carries them to bucket elevator to blender in background.

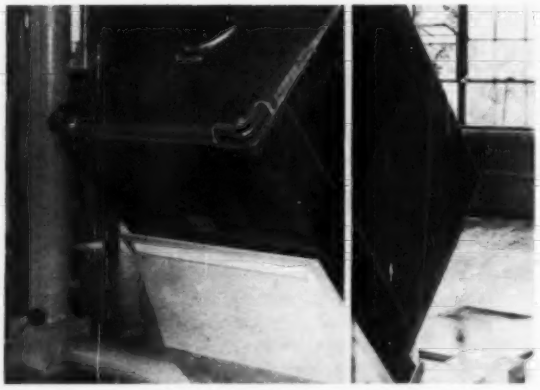


FIG. 4—An employee tilts Tote Bin on Tote Tilt. Materials are screw-conveyed through sifters at left, then to hoppers.

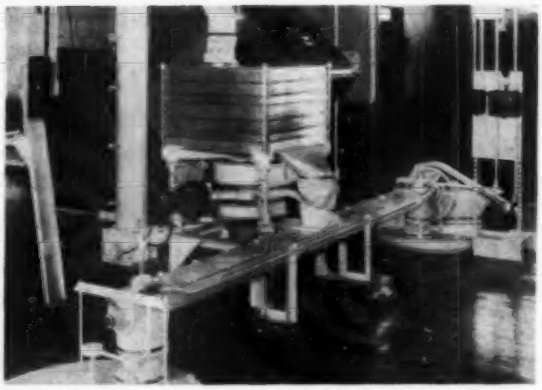


FIG. 5—Tote Bin on Tote Tilt, discharging adhesive into screw conveyer.

The need for quality and sanitation control is at its peak in the dental and medical industries. In fact, at the Binghamton, New York, plant of Clark-Cleveland, Inc., manufacturers of Fasteeth Denture Powder, quality control and sanitation are not only the prime considerations involved, they are almost canon laws.

Clark-Cleveland recently modified production facilities in their four-story plant, adding a new method of materials handling—the use of hermetically-sealed aluminum Tote Bins and their companion units, Tote Tilts, which convert the aluminum containers into self-discharging hoppers. By modern handling methods, they assure a pure product, allow diversity and flexibility of labor and provide for expansion.

Tote Bins have a capacity of 74-cubic feet of dry materials. At Clark-Cleveland, they hold the formulated adhesive product prior to packaging operations. In other installations, they usually store and transport the raw materials from point of receipt to point of processing. By using Tote Tilts, several ingredients may be introduced into process at once, in proper proportions.

At Clark-Cleveland, however, no raw materials are carried in the bins. A dump container, holding the ingredients of the finished product, empties into a screw conveyor which carries the ingredients to a bucket elevator through a seven-foot screw to a 50-cubic foot blender in which they undergo a blending cycle.

From the blender, the product is conveyed through a four-foot screw conveyor to an eight-foot vertical screw, thence through a short horizontal screw to an orlon spout which fills the Tote Bins. The formulation now complete, the bin is transported to storage by a Raymond hand-lift. In storage, the hermetically-sealed bins keep the hygienic product safe from contamination.

After tests are made of the formulated product, the Tote Bins are taken from storage to a Tote Tilt. The ingredients are discharged from the bins via the Tilts, through screw conveyors to sifters, then are screw-

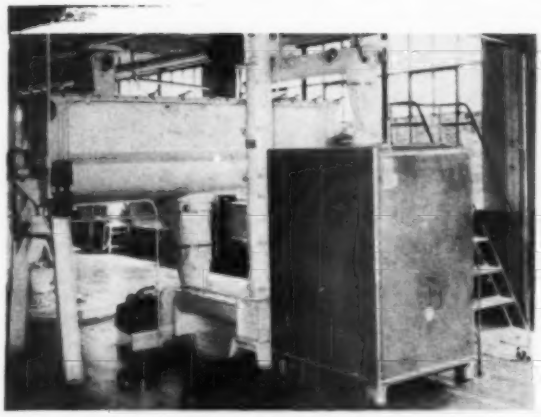


FIG. 2—From 50-cubic foot blender, materials are conveyed to Tote Bins. Orlon spout is used for filling the 74-cubic foot hermetically sealed aluminum container.

FIG. 3—After filling the Tote Bin, an employee removes it to storage area by handlift. After sample of adhesive is tested in laboratory, material goes through sifters to packaging lines.

FIG 6—Over-all view of Tote System in operation showing all component units.

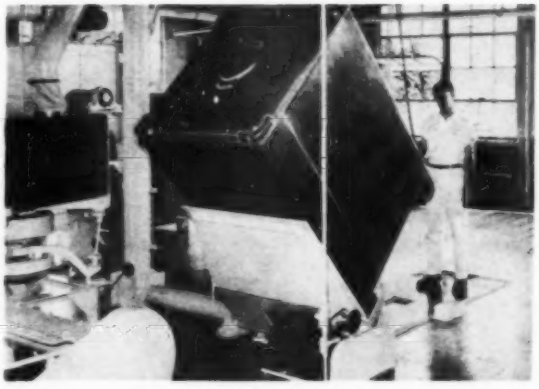


FIG. 7—Dual hoppers feed the two packaging lines incorporated in the system.

conveyed to hoppers which feed the dual production lines. All equipment is electrically controlled. At no point from the time of formulation to packaging is the product in danger of moisture pickup, of contamination, of infestation.

The fact that all six Tote Bins owned by Clark-Cleveland are utilized in intra-plant operations makes this installation unique in itself. Few plants utilize the system in this manner. Most operations consist of a combination of intra- and inter-plant operations.

For raw materials, the bins act as transportation containers. They may be filled at the source of material, or at the manufacturer's plant via bulk vehicles. If they are filled at the source of raw material, they are transported by any flat-bed conveyance—most often by truck, but also by rail or barge, depending upon circumstances and facilities available to the user.

The hermetic seal and aluminum construction allow for complete protection of transported materials and possess the corrosion-resisting qualities of aluminum.

From the flat-bed conveyor, they are lifted off by fork-truck or handlift and carried into storage, where they serve in the place of palleted bags or corrugated containers. In this capacity, the bins can be tiered to save up to 60% of warehouse space.

Then, from storage, the bins are employed in intra-plant operations. The empties are returned for refilling. Normal labor, space and container savings allow amortization of the system usually within two years, often within one year.

Clark-Cleveland officials are pleased with the installation and are considering its use in the manufacture of a deodorant powder. The inherent dustiness of the powder conceivably could create a problem, but management feels that the dust-tight bins will remove such hazards and are looking into that possibility now.

Tote Bins and Tote Tilts are manufactured by Tote Systems, Inc., Beatrice Nebr.

Bone-Setting With Polyurethane

Since the turn of the century, it has been the dream of surgeons to be able to treat the human body without external splinting and supporting. Many devices have been worked out and a few have been successful. Fractured legs on dogs have been held together for healing purposes in externally held braces. Arms have been held in traction for specific purposes in patients where casting was undesirable. Many men have survived critical breaks and fractures with the insertion of metal pieces. Still all of these methods and approaches were no more than imaginative substitutes.

"It has long been felt that a chemical compound could be developed which could be poured in liquid form into a fracture site and produce bonding of the diseased or fractured ends of bone. Perusal of the chemical literature disclosed the abilities of polyurethane foams, in rigid form, to meet the requirements for strength, immobilization, nontoxicity, adhesion and cohesion, torsional stabilization and ease of handling required for bone surgery. Polyurethane resins are based on isocyanate chemistry.

"For the purpose of producing a dense, rigid, cellular foam for orthopedic use, a prepolymer was prepared by reacting a trihydroxy resin with an excess of diisocyanate. This prepolymer was mixed at the time of surgery with water and a catalyst.

"It is apparent that the prepolymer added is an active material, and it therefore bonds to the surfaces to be held, bridged, filled or strengthened. The polyurethane, in and during its formation, becomes an intimate part of the bone. It is this property that differentiates it from a glue or common cement-type bonding agent. In both animal and human experimentation, there is positive evidence that this occurs."

The above is an abstract of a paper presented by Dr. Michael P. Mandarino in Chicago in collaboration with Dr. Joseph E. Salvatore of the Department of Surgery, Hahnemann Medical College and Hospital, Philadelphia. Their experiments give promise of a broad application of such materials and may, in fact, constitute the beginning of a new science. Bone surgery may find a new sphere of application through the use of modern polymers.

The rigidity of bones is due to deposits of inorganic salts, chiefly calcium phosphate combined with some calcium carbonate, between the living components of the tissue. Cells are scattered throughout this hard matrix and at intervals it is penetrated by blood vessels and nerves which are necessary for the maintenance of its living parts. The matrix is also penetrated by a foundation of organic fibrils produced by the cells.

Bone occurs in 2 forms: compact bone such as the walls of long bones of the skeleton, and cancellous bone composed of a reticular arrangement of slender parts which results in a spongy appearance. The latter is found in the end of long bones.

Most materials which we class as adhesives aren't adhesives until they reach a certain stage. Glue won't hold anything to anything until it dries. Many plastics have to be heated or allowed to cool. Epoxies won't work at all until a catalyst is added. Polyurethane is not considered by its manufacturers nor by most of its users as an adhesive. However, at one stage during its expansion it does take hold and become an adhesive. It is the adhesive quality of polyurethane which allows it to be used with tremendous versatility of applications.

How to "Glue" Polyethylene

Standard starch and dextrin adhesives are coming into use for what long seemed the least likely purpose—the "gluing" of polyethylene. The trick was turned by the Lowe Paper Co., of Ridgefield, N. J., which recently developed a surface treating process which makes polyethylene-coated paper and boxboard readily glueable. Low-cost adhesives and standard box- and bag-sealing machinery can be used.

The process appears to eliminate a long-standing stumbling block for both the plastics and packaging industries. Improved heat-sealing techniques and the continuing search for special polymeric adhesives have provided only a partial answer to the bonding problems.

Lowe's process recently proved itself when the Mid-York Press of Norwich, N. Y., produced a glue-sealed carton of polyethylene-coated boxboard using an ordinary dextrin adhesive and standard glue-sealing machinery.

The carton, used by the Norwich Pharmacal Co., is ideally suited for the product (suppositories pouched in foil) because the extrusion-coated polyethylene gives a highly effective grease barrier. Traces of the product left on the foil-pouch would pass through uncoated boxboard and stain the package.

Details of the surface-treating process have not been released, but after gluing tests with standard starch adhesives rates up to 80,000 cartons an hour were reported.

New applications for polyethylene-coated paper and board, made possible by the Lowe development, range from bar soap wrappers to frozen food cartons. E. I. du Pont de Nemours & Co., Inc., which supplied the "Alathon" polyethylene resin used in the Norwich Pharmacal carton, sees potential markets including boxes for chlorinated powdered detergents, cereals, cake mixes, and other products requiring sift-proof containers where a loose inner liner is now employed.

In frozen food packaging, cartons lined with polyethylene would need no overwrap, indicating large potential savings for packagers.

Nomenclature

for the Adhesives Industry

Until the present century, the history of adhesives had been largely the story of glue and its applications. There was no particular need to define a *glue*. That is, it seemed sufficient to mention the simple word—and the listener understood. The situation persisted even after the use of starch and other vegetable adhesives had become universal.

However, with the introduction of the myriad compounds whose prime characteristics are the permanent joining of materials, the simple word *glue* no longer filled the requirements of language. Even this might have been circumvented had there not been an acute need to define special properties, characteristics, applications, and types of adhesives. (Yes, even the word *adhesive* needed definition!)

We have entered an era of highly advanced scientific achievement totally unprepared in the field of adhesives. This is an era which demands precise planning and expert use. The sciences which produced the adhesives seemed to have looked upon them as a by-product, a special dividend. Little was done to establish the counterpart science which allows us to make full and efficient use of these wonderful new substances. To develop this science men must be able to communicate.

Meanwhile, huge industries have grown out of the scientific progress. These industries have had to invent a jargon of communication and, as is so often the case, have found themselves at a loss. Such was the confusion and the turmoil that there was no agreement on such basic terms as "adhesive", "tack", "bond", etc.

Slowly, the American Society for Testing Materials has been working out these fundamental problems through its Committee D-14 on Adhesives, and ASTM has published "Standard Definitions of Terms Relating to Adhesives" which it designates "D 907-55". The listing which follows is based upon ASTM definitions and is published solely as a guide to trade terminology since it includes definitions which have not as yet been accepted as standard by ASTM.

A-Stage, n.—An early stage in the reaction of a thermosetting resin in which the material is still soluble in certain liquids and fusible. (See also B-Stage and C-Stage.)

Adhere, v.—To cause two surfaces to be held together by adhesion.

Adherend, n.—A body which is held to another body by an adhesive. (See also Substrate.)

Adhesion, n.—The state in which two surfaces are held together by interfacial forces which may consist of valence forces or interlocking action, or both. (See also Adhesion, Mechancial and Adhesion, Specific.)

Adhesion, Mechanical.—Adhesion between surfaces in which the adhesive holds the parts together by interlocking action. (See also Adhesion, Specific.)

Adhesion, Specific.—Adhesion between surfaces which are held together by valence forces of the same type as those which give rise to cohesion. (See also Adhesion, Mechanical.)

Adhesive, n.—A substance capable of holding materials together by surface attachment.

Adhesive, Assembly.—An adhesive which can be used for bonding parts together, such as in the manufacture of a boat, airplane, furniture, and the like.

Adhesive, Cold-Setting.—An adhesive which sets at temperatures below 20°C. (68°F.). (See also Adhesive, Hot-setting; Adhesive, Intermediate Temperature Setting; and Adhesive, Room Temperature Setting.)

Adhesive Dispersion.—A two-phase system in which one phase is suspended in a liquid.

Adhesive, Hot-Setting.—An adhesive which requires a temperature at or above 100°C (212°F.) to set it. (See also Adhesive, Cold-Setting; Adhesive, Intermediate Temperature Setting; and Adhesive, Room Temperature Setting.)

Adhesive, Intermediate Temperature Setting.—An adhesive which sets in the temperature range of 31 to 99°C. (87 to 211°F.). (See also Adhesive, Cold-Setting; Adhesive, Hot-Setting; and Adhesive, Room Temperature Setting.)

Adhesive, Pressure-Sensitive.—An adhesive made so as to adhere to a surface at room temperature by briefly applied pressure alone.

Adhesive, Room Temperature Setting.—An adhesive which sets in the temperature range of 20 to 30°C. (68 to 86°F.), in accordance with the limits for Standard Room Temperature specified in the Standard Methods of Conditioning Plastics and Electrical Insulating Materials for Testing (A.S.T.M. Designation: D-618). (See also Adhesive, Cold-Setting; Adhesive, Hot-Setting; and Adhesive, Intermediate Temperature Setting.)

Adhesive, Separate Application.—A term used to describe an adhesive consisting of two parts, one part being applied to one adherend and the other part to the other adherend and the two brought together to form a joint.

Adhesive, Warm-Setting.—A term which is sometimes used as a synonym for Intermediate Temperature Setting Adhesive. (See Adhesive, Intermediate Temperature Setting.)

Aging Time.—See Time, Joint Conditioning.

Aggressive Tack.—See Tack, Dry

Amylaceous, adj.—Pertaining to, or of the nature of, starch; starchy.

Assembly, n.—A group of materials or parts, including adhesive, which has been placed together for bonding or which has been bonded together.

Assembly Adhesive.—See Adhesive, Assembly.

Assembly Glue.—See Adhesive, Assembly.

Assembly Time.—See Time, Assembly.

B-Stage, n.—An intermediate stage in the reaction of a thermosetting resin in which the material softens when heated and swells in contact with certain liquids, but may not entirely fuse or dissolve. Resins in thermosetting molding compounds are usually in this stage. (See also A-Stage and C-Stage.)

Bag Molding.—A method of molding or bonding involving the application of fluid pressure, usually by means of air, steam, water, or vacuum, to a flexible cover which, sometimes in conjunction with the rigid die, completely encloses the material to be bonded.

Binder, n.—A component of an adhesive composition which is primarily responsible for the adhesive forces which hold two bodies together. (See also Extender and Filler.)

Blister, n.—An elevation of the surface of an adherend, somewhat resembling in shape a blister on the human skin; its boundaries may be indefinitely outlined and it may have burst and become flattened.

Blocking, n.—An undesired adhesion between touching layers of a material, such as occurs under moderate pressure during storage or use.

Bond, n.—The attachment at an interface between an adhesive and an adherend. (See also Joint.)

Bond, v.—To attach materials together by adhesives.

Bond Strength.—The unit load applied in tension, compression, flexure, peel, impact, cleavage, or shear, required to break an adhesive assembly with failure occurring in or near the plane of the bond.

C-Stage, n.—The final stage in the reaction of a thermosetting resin in which the material is relatively insoluble and infusible. Thermosetting resins in a fully cured adhesive layer are in this stage.

Catalyst, n.—A substance which markedly speeds up the cure of an adhesive when added in minor quantity as compared to the amounts of the primary reactants. (See also Hardener and Inhibitor.)

Cement, n.—See Adhesive.

Cement, v.—See Bond, v.

Closed Assembly Time.—See Time, Assembly.

Cohesion, n.—The state in which the particles of a single substance are held together by primary or secondary valence forces. As used in the adhesive field, the state in which the particles of the adhesive (or the adherend) are held together.

Cold Flow.—See Creep.

Cold Pressing.—A bonding operation in which an assembly is subjected to pressure without the application of heat.

Cold-Setting Adhesive.—See Adhesive, Cold-Setting.

Colophony, n.—See Rosin.

Condensation, n.—A chemical reaction in which two or more molecules combine with the separation of water or some other simple substance. If a polymer is formed, the process is called polycondensation. (See also Polymerization.)

Conditioning Time.—See Time, Joint Conditioning.

Consistency, n.—That property of a liquid adhesive by virtue of which it tends to resist deformation.

Copolymer.—See Polymer.

Copolymerization.—See Polymerization.

Crazing, n.—Fine cracks which may extend in a network on or under the surface of or through a layer of adhesive.

Creep, n.—The dimensional change with time of a material under load, following the initial instantaneous elastic or rapid deformation. Creep at room temperature is sometimes called Cold Flow.

Cross Laminated.—See Laminated, Cross.

Cure, v.—To change the physical properties of an adhesive by chemical reaction, which may be condensation, polymerization, or vulcanization; usually accomplished by the action of heat and catalyst, alone or in combination with or without pressure.

Curing Time.—See Time, Curing.

Delamination, n.—The separation of layers in a laminate because of failure of the adhesive, either in the adhesive itself or at the interface between the adhesive and the adherend, or because of cohesive failure of the adherend.

Diluent, n.—An ingredient, usually added to an adhesive to reduce the concentration of bonding materials. (See also Extender.)

Doctor-Roll.—A roller mechanism which is revolving at a different surface speed, or in an opposite direction, resulting in a wiping action for regulating the adhesive supplied to the spreader roll.

Doctor-Bar or Blade.—A scraper mechanism which regulates the amount of adhesive on the spreader rolls or on the surface being coated.

Double Spread.—See Spread.

Dry, v.—To change the physical state of an adhesive on an adherend by the loss of solvent constituents by evaporation or absorption, or both. (See also Cure and Set.)

Dry Strength.—See Strength, Dry.

Dry Tack.—See Tack, Dry.

Drying Time.—See Time, Drying.

Elastomer, n.—A material which at room temperature can be stretched repeatedly to at least twice its original length and, upon immediate release of the stress, will return with force to its approximate original length.

Extender, n.—A substance, generally having some adhesive action, added to an adhesive to reduce the amount of the primary binder required per unit area. (See also Binder and Filler.)

Filler, n.—A relatively nonadhesive substance added to an adhesive to improve its working properties, permanence, strength, or other qualities. (See also Binder and Extender.)

Flow, n.—Movement of an adhesive during the bonding process, before the adhesive is set.

Gel, n.—A semisolid system consisting of a network of solid aggregates in which liquid is held.

Gelation, n.—Formation of a gel.

Glue, n.—Originally, a hard gelatin obtained from hides, tendons, cartilage, bones, etc., of animals. Also, an adhesive prepared from this substance by heating with water. Through general use the term is now synonymous with the term "adhesive". (See also Adhesive, Mucilage, Paste and Sizing.)

Glue, v.—See Bond, v.

Gum, n.—Any of a class of colloidal substances, exuded by or prepared from plants, sticky when moist, composed of complex carbohydrates and organic acids, which are soluble or swell in water. (See also Adhesive, Glue, Resin.)

Hardener, n.—A substance or mixture of substances added to an adhesive to promote or control the curing reaction by taking part in it. The term is also used to designate a substance added to control the degree of hardness of the cured film. (See also Catalyst.)

Hot-Setting Adhesive.—See Adhesive, Hot-Setting.

Inhibitor, n.—A substance which slows down chemical reaction. Inhibitors are sometimes used in certain types of adhesives to prolong storage or working life.

Intermediate Temperature Setting Adhesive.—See Adhesive, Intermediate Temperature Setting.

Joint, n.—The location at which two adherends are held together with a layer of adhesive. (See also Bond, n.)

Joint, Lap.—A joint made by placing one adherend partly over another and bonding together the overlapped portions. (See also Joint, Scarf.)

Joint, Scarf.—A joint made by cutting away similar angular segments of two adherends and bonding the adherends with the cut areas fitted together. (See also Joint, Lap.)

Joint, Starved.—A joint which has an insufficient amount of adhesive to produce a satisfactory bond.

Laminate, n.—A product made by bonding together two or more layers of material or materials. (See also Laminated, Cross and Laminated, Parallel.)

Laminate, v.—To unite layers of material with adhesive.

Laminated, Cross.—A laminate in which some of the layers of material are oriented at right angles to the remaining layers with respect to the grain or strongest direction in tension. (See also Laminated, Parallel.)

Laminated, Parallel.—A laminate in which all the layers of material are oriented approximately parallel with respect to the grain or strongest direction in tension. (See also Laminated, Cross.)

Lamination, n.—The process of preparing a laminate. Also, any layer in a laminate.

Lap Joint.—See Joint, Lap.

Mechanical Adhesion.—See Adhesion, Mechanical, and Adhesion, Specific.

Modifier, n.—Any chemically inert ingredient added to an adhesive formulation that changes its properties. (See Filler, Plasticizer and Extender.)

Monomer, n.—A relatively simple compound which can react to form a polymer. (See also Polymer.)

Mucilage, n.—An adhesive prepared from a gum and water. Also in a more general sense, a liquid adhesive which has a low order of bonding strength. (See also Adhesive, Glue, Paste, and Sizing.)

Novolak, n.—A phenolic-aldehydic resin which, unless a source of methylene groups is added, remains permanently thermoplastic. (See also Resinoid and Thermoplastic.)

Parallel Laminated.—See Laminated, Parallel.

Paste, n.—An adhesive composition having a characteristic plastic-type consistency, that is, a high order of yield value, such as that of a paste prepared by heating a mixture of starch and water and subsequently cooling the hydrolyzed product. (See also Adhesive, Glue, Mucilage, and Sizing.)

Penetration, n.—The entering of an adhesive into an adherend.

Permanence.—The resistance of an adhesive bond to deteriorating influences.

Pick-up Roll.—A spreading device where the roll for picking up the adhesive runs in a reservoir of adhesive.

Plasticity.—A property of adhesives which allows the material to be deformed continuously and permanently without rupture upon the application of a force that exceeds the yield value of the material.

Plasticizer, n.—A material incorporated in an adhesive to increase its flexibility, workability, or distensibility. The addition of the plasticizer may cause a reduction in melt viscosity, lower the temperature of the second-order transition, or lower the elastic modulus of the solidified adhesive.

Plywood.—A cross-bonded assembly made of layers of veneer or veneer in combination with a lumber core or plies joined with an adhesive. Two types of plywood are recognized, namely (1) veneer plywood, and (2) lumber core plywood.

Polycondensation.—See Condensation.

Polymer, n.—A compound formed by the reaction of simple molecules having functional groups which permit their combination to proceed to high molecular weights under suitable conditions. Polymers may be formed by polymerization (addition polymer) or polycondensation (condensation polymer). When two or more monomers are involved, the product is called a copolymer.

Polymerization, n.—A chemical reaction in which the molecules of a monomer are linked together to form large molecules whose molecular weight is a multiple of that of the original substance. When two or more monomers are involved, the process is called copolymerization or heteropolymerization. (See also Condensation.)

Pot Life.—See Working Life.

Pressure-Sensitive Adhesive.—See Adhesive, Pressure-Sensitive.

Primer.—A coating applied to a surface, prior to the application of an adhesive, to improve the performance of the bond.

Resin, n.—Any of a class of solid or semi-solid organic products of natural or synthetic origin, generally of high molecular weight with no definite melting point. (See also Gum).

Resinoid, n.—Any of the class of thermosetting synthetic resins, either in their initial temporarily fusible state or in their final infusible state. (See also Novolak and Thermosetting.)

Resite, n.—An alternate term for C-Stage.

Resitol, n.—An alternate term for B-Stage.

Resol, n.—An alternate term for A-Stage.

Retrogradation, n.—A change of starch pastes from low to high consistency on aging.

Room Temperature Setting Adhesive.—See Adhesive, Room Temperature Setting.

Rosin, n.—A resin obtained as a residue in the distillation of crude turpentine from the sap of the pine tree (gum rosin) or from an extract of the stumps and other parts of the tree (wood rosin).

Scarf Joint.—See Joint, Scarf.

Self-Curing, adj.—See Self-Vulcanizing.

Self-Vulcanizing, adj.—Pertaining to an adhesive which undergoes vulcanization without the application of heat.

Separate Application Adhesive.— See Adhesive, Separate Application.

Set, v.—To convert an adhesive into a fixed or hardened state by chemical or physical action, such as condensation, polymerization, oxidation, vulcanization, gelation, hydration, or evaporation of volatile constituents. (See also Cure and Dry.)

Shelf Life.—See Storage Life.

Shortness, n.—A qualitative term that describes an adhesive that does not string, cotton, or otherwise form filaments or threads during application.

Single Spread.—See Spread.

Size, n.—See Sizing.

Sizing, n.—The process of applying a material on a surface in order to fill pores and thus reduce the absorption of the subsequently applied adhesive or coating or to otherwise modify the surface properties of the substrate to improve the adhesion. Also, the material used for this purpose. The latter is sometimes called Size.

Slippage, n.—The movement of adherends with respect to each other during the bonding process.

Solids Content, n.—The percentage by weight of the non-volatile matter in an adhesive.

Specific Adhesion.—See Adhesion, Specific and Adhesion, Mechanical.

Spread, n.—The quantity of adhesive per unit joint area applied to an adherend. It is preferably expressed in pounds of liquid or solid adhesive per thousand square feet of joint area. (1) Single Spread refers to application of adhesive to only one adherend of a joint; (2) Double Spread refers to application of adhesive to both adherends of a joint.

Storage Life.—The period of time during which a packaged adhesive can be stored under specified temperature conditions and remain suitable for use. Sometimes called Shelf Life. (See also Working Life.)

Starved Joint.—See Joint, Starved.

Strength, Dry.—The strength of an adhesive joint determined immediately after drying under specified conditions or after a period of conditioning in the standard laboratory atmosphere. (See also Strength, Wet.)

Strength, Wet.—The strength of an adhesive joint determined immediately after removal from a liquid in which it has been immersed under specified conditions of time, temperature, and pressure.

Stringiness, n.—The property of an adhesive that results in the formation of filaments or threads when adhesive transfer surfaces are separated. (See Webbing.)

Substrate, n.—A material upon the surface of which an adhesive-containing substance is spread for any purpose, such as bonding or coating. A broader term than adherend. (See also Adherend.)

Syneresis.—The exudation of small amounts of liquid by gels on standing.

Tack, n.—Stickiness of an adhesive.

Tack, Dry.—The property of certain adhesives, particularly nonvulcanizing rubber adhesives, to adhere on contact to themselves at a stage in the evaporation of volatile constituents, even though they seem dry to the touch. Sometimes called Aggressive Tack.

Tack Range.—The period of time in which an adhesive will remain in the tacky-dry condition after application to an adherend, under specified conditions of temperature and humidity.

Tacky-Dry, adj.—Pertaining to the condition of an adhesive when the volatile constituents have evaporated or been absorbed sufficiently to leave it in a desired tacky state.

Thermoplastic, adj.—Capable of being repeatedly softened by heat and hardened by cooling.

Thermoplastic, n.—A material which will repeatedly soften when heated and harden when cooled.

Thermoset, adj.—Pertaining to the state of a resin in which it is relatively infusible.

Thermoset, n.—A material which will undergo or has undergone a chemical reaction by the action of heat, catalysts, ultraviolet light, etc., leading to a relatively infusible state.

Thermosetting, adj.—Having the property of undergoing a chemical reaction by the action of heat, catalysts, ultraviolet light, etc., leading to a relatively infusible state.

Thinner, n.—A volatile liquid added to an adhesive to modify the consistency or other properties. (See also Diluent and Extender.)

Thixotropy.—A property of adhesive sytems to thin upon isothermal agitation and to thicken upon subsequent rest.

Time, Assembly.—The time interval between the spreading of the adhesive on the adherend and the application of pressure or heat, or both, to the assembly.

Time, Curing.—The period of time during which an assembly is subjected to heat or pressure, or both, to cure the adhesive. (See also Time, Joint Conditioning and Time, Setting.)

Time, Drying.—The period of time during which an adhesive on an adherend or an assembly is allowed to dry with or without the application of heat or pressure, or both. (See also Time, Curing; Time, Joint Conditioning; and Time, Setting.)

Time, Joint Conditioning.—The time interval between the removal of the joint from the conditions of heat or pressure, or both, used to accomplish bonding and the attainment of approximately maximum bond strength. Sometimes called Joint Aging Time.

Time, Setting.—The period of time during which an assembly is subjected to heat or pressure, or both, to set the adhesive. (See also Time, Curing; Time, Joint Conditioning, and Time, Drying.)

Viscosity, n.—The internal frictional resistance of an adhesive to flow when that resistance is directly proportional to the applied force.

Viscosity Coefficient.—The sharing stress tangentially applied which will induce a velocity gradient. A material has a viscosity of one poise when a shearing stress of one dyne per square centimeter produces a velocity gradient of

$$\frac{1 \text{ cm per sec.}}{\text{sec.}}$$

(See Viscosity.)

Warm-Setting Adhesive.—See Adhesive, Warm-Setting.

Warp, n.—A significant variation from the original, true or plane surface.

Webbing, n.—Filaments or threads that may form when adhesive transfer surfaces are separated. (See Stringiness.)

Wet Strength.—See Strength, Wet.

Wood, Built-Up Laminated.—An assembly made by joining layers of lumber with mechanical fastenings so that the grain of all laminations is essentially parallel.

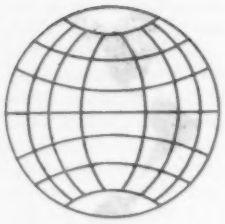
Wood, Glued Laminated.—An assembly made by bonding layers of veneer or lumber with an adhesive so that the grain of all laminations is essentially parallel.

Wood Failure.—The rupturing of wood fibers in strength tests on bonded specimens, usually expressed as the percentage of the total area involved which shows such failure.

Wood Veneer.—A thin sheet of wood, generally within the thickness range of 0.01 to 0.25 in., to be used in a laminate.

Working Life.—The period of time during which an adhesive, after mixing with catalyst, solvent, or other compounding ingredients, remains suitable for use. (See also Storage Life.)

Yield Value.—The stress (either normal or shear) at which a marked increase in deformation occurs without an increase in load.



NEWS OF THE ADHESIVES WORLD

Corn Products Refining and Best Foods Merge

Formation of a new company through the merger of Corn Products Refining Co. and The Best Foods, Inc., has been approved by the stockholders of both corporations. The newly created Corn Products Co. has total annual sales of over $600 million.

Details of the new company organization were announced jointly by William T. Brady, president and chief executive officer of the new enterprise, Corn Products Co., and Leonard G. Blumenschine, president of the Best Foods Division of Corn Products Co., following a recent meeting of the board of directors.

In addition to his responsibilities as president of the Best Foods Division, Mr. Blumenschine was elected to the board of directors of the new company and joins its Executive Committee. Aaron S. Yohalem, formerly executive vice-president of The Best Foods, Inc., will continue in the same capacity with the Best Foods Division of Corn Products, and will serve also as a vice-president of the new company.

Adds Bulk Materials Line

The merger adds the entire line of Best Foods bulk materials to the 450 industrial bulk products already manufactured by Corn Products Refining Co. Corn starches, syrups, dextrose and dextrines made by Corn Products are used in over 60 industries including adhesives, baking, brewing, canning, confectionery, ice cream, pharmaceuticals, paper, textiles, printing inks and products of the foundry and tanning industries.

In addition to the industrial products the merger brings together the consumer products manufactured by both companies and distributed principally through the grocery trade.

Under the terms of the merger agreement, each outstanding share of common stock of Corn Products Refining Co. was converted into one share of common stock of the new company. Each outstanding share of 7 per cent cumulative preferred stock of Corn Products Refining Co. was converted into 25-year, 4⅝ per cent subordinated debentures at the rate of $175 principal amount of subordinated debentures for every share of preferred stock, which had a par value of $100.

Each outstanding share of common stock of The Best Foods, Inc., was converted into 1.6 shares of the new company. No fractional shares were issued and arrangements were made whereby a holder entitled to a fractional share has the option, for a limited time, of either buying an additional fractional share to complete a full share or selling his fractional share. It is expected that an initial regular quarterly dividend of 50 cents a share will be paid in January, 1959.

Corn Products Refining Co. plants are located in Argo and Pekin, Ill.; North Kansas City, Mo.; Corpus Christi, Texas, and Yonkers, N. Y., and there are milling operations in Vermont, Massachusetts, New York, North Carolina and Illinois, and dog food plants in New York and Illinois.

Corn Products also operates processing plants packaging facilities in 17 countries abroad including Canada, Mexico, Argentina, Brazil, Colombia, England, Scotland, Ireland, France, Holland, Belgium, Denmark, Germany, Switzerland, Italy, India and South Africa.

Moves Sales Office

Beach-Russ Co., manufacturer of a complete line of rotary high vacuum pumps, compressors and gas boosters, has moved it general sales office to new quarters at 420 Lexington Ave., New York 17, N. Y. The company moved to the new location, after over thirty-five years in the Hudson Terminal Building in downtown Manhattan, for the convenience of Beach-Russ customers and regional sales personnel.

BRI Conference Talk Stresses Adhesives

The Building Research Institute conference on flooring, held on September 17 and 18 at the Sheraton-Park Hotel, Washington, D. C., featured two talks on "Fastening Methods for Base and Finish Flooring," by Jerome L. Been, executive vice-president of Rubber & Asbestos Corp., and George E. Stern, research professor at Virginia Polytechnic Institute.

In his talk, Mr. Been stressed the rapidly increasing importance of adhesives in the installation of modern flooring, film adhesives, limiting or severe conditions where special adhesives are required, the effect of alkali, moisture, heat, etc. on flooring and adhesives bonds, treatment and adhesive installation of waterproofing membranes, the relationship between the adhesive and the use of mastic or latex underlayment, roofing felt, etc. Mr. Been concluded with a discussion of future development work in prospect. Mr. Stern discussed mechanical fasteners for resilient, smooth-surface flooring.

Open To Public

Sponsored by nine leading manufacturers of flooring materials and one fastenings manufacturer, the two-day conference was open to the interested public as well as to the BRI members and guests. Among the features was a report on a nation-wide BRI survey of architects, engineers, building contractors, building owners, home builders, flooring contractors and lumber and building materials dealers to determine the most prevalent problems with resilient flooring and their solutions.

In addition, two open discussion workshops were held to formulate recommendations on bases and fastening methods and on installation and maintenance techniques to improve the performance of tire and sheet flooring materials.

Form New Chemical Firm

Air Reduction Co., Inc. and Mastic Tile Corp. of America, both in New York City, have issued a joint statement announcing the formation of the Cumberland Chemical Corp. for the production of materials to be used by Mastic Tile in the manufacture of floor coverings and other building construction products. Air Reduction holds a 60 per cent stock interest and Mastic Tile a 40 per cent stock interest in the new company. Cumberland will construct and operate a plant adjacent to existing Air Reduction facilities at Calvert City, Ky., at which vinyl chloride monomer and vinyl chloride polymer will be produced. The facility will also produce substantial quantities of a new type of plasticizer. Acetylene, one of the major raw materials, will be supplied by Air Reduction. Capital cost of the new plant, which is scheduled for completion early in 1960, is estimated at approximately $10,000,000.

John A. Hill, president of Air Reduction, will serve as chairman, and Seymour Milstein, president of Mastic Tile, as vice-chairman of the new corporation, which will be managed by Air Reduction Chemical Co. C. J. McFarlin, president of the chemical company, will also serve as president of Cumberland. Other board members are J. D. Gunther, a vice-president of Air Reduction and R. B. Schneider, a vice-president of the Empire Trust Co.

Abbé Moves Offices

Abbé Engineering Co. has moved its general sales offices to larger quarters in the Graybar Building at 420 Lexington Ave., New York, N. Y. The new telephone number is Oregon 9-7636. The centrally located midtown office was selected in order to give better service to Abbé customers and regional sales personnel. Abbé manufactures the Abbé industrial pebble, ball and jar mills, mixers, conical blenders, cutters, sifters, and Kent ring-roll mills.

Plans Container Unit

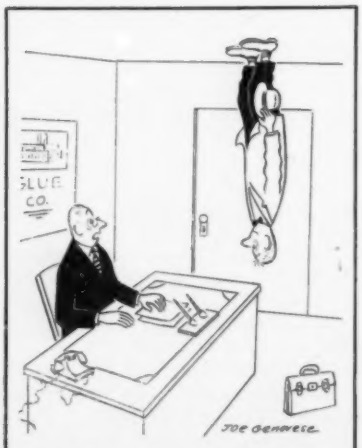
Olin Mathieson Chemical Corp., Baltimore, Md., has announced plans to open a corrugated container plant in Kansas City, Kansas, in the last quarter of this year. According to the company, the facility will have four times the productive capacity of the present Kansas City unit, which will be replaced.

5th Annual NAFM Fair

The fifth annual Supply Equipment and Fabric Fair, held by the National Association of Furniture Manufacturers at the Conrad Hilton Hotel, Chicago, Ill., on August 24-27, drew a record 1900 registered visitors including furniture manufacturers from all over the country and from 15 foreign countries. It is believed that the presence of woodworking machinery from home and abroad, appearing at the supply show for the first time, greatly stimulated both exhibitors and manufacturers. The Fair demonstrated a great variety of products, techniques and ideas, and displays ranged from complete model conveyor systems to pneumatic tack hammer "shooting contest." Sewing machines that do automatic boxing, polyether foam cushions produced on the spot, and molded plastic drawers attracted much attention.

Plans New Indian Unit

Johnson & Johnson, New Brunswick, N. J., utilizing the United States investment guaranty in India, has taken out government insurance protecting the company against failure to be able to convert investment funds and rupee earnings into dollars, current reports state. A Johnson & Johnson subsidiary will build and operate a manufacturing plant in India, and Indian investors are expected to participate in the subsidiary. The specific amount of the guaranty will be determined after the company has made its full investment in that country.



"All right Mr. Jones, I'm convinced your adhesive formula has something!"

Receives Belgian License

Emulsions and solutions of acrylic polymers used for plastic, paint, coating and adhesive applications will be manufactured and sold by the Catalin Corp. of America, New York, N. Y., under a ten-year license agreement with Union Chimique Belge, S. A., Brussels, Belgium. Union Chimique Belge, a leading manufacturer of chemicals in Europe, will supply Catalin with data and information necessary for the manufacture of products covered in the agreement. These chemical specialties will be produced at three plants located at Fords, N. J., Thomasville, N. C., and Calumet City, Ill. A technician from Union Chimique will help set the manufacturing process in motion and a Catalin technician will be sent to one of the Belgian firm's plants to observe the manufacture of products covered in the agreement. The companies also will exchange technical information on improvements and new developments in manufacturing processes, formulations and applications of the licensed chemical specialties.

Fuller Adhesives Unit

H. B. Fuller Co., St. Paul, Minn., has announced plans to erect a new adhesives manufacturing plant in Fairfax, Kansas. The new structure will be erected on a 1¾ acre land site, and will have 14,325 square feet for production and warehouse with an additional 2,333 square feet of air-conditioned office space. It will be constructed of structural steel framing with non-load-bearing exterior walls of brick and concrete block. Glass, aluminum colored panels, and brick will be used for the exterior. Completion is scheduled for early 1959. Kansas City operations were established in 1943 as the first Fuller branch plant. The company now has operating plants and warehouses in 23 cities.

Paper Firms Merge

Rap-In-Wax Paper Co., Minneapolis, Minn., has acquired the United States Packaging Corp., Paterson N. J., through an exchange of stock and an undisclosed amount of cash, current reports state. U. S. Packaging will be operated as a subsidiary of Rap-In-Wax under its present management. A. R. Cozzolino continues as president, and Gustav Rickelmann as vice-president for manufacturing.

G-E Appointments

Chemical and Metallurgical Division of the General Electric Co., Pittsfield, Mass., has announced the appointment of Dr. A. Eugene Schubert, manager of the Chemical Development Department, as general manager of the Chemical Materials Department, succeeding Sam L. Brous, who has been named marketing manager. James W. Reynolds, previously marketing manager, has been named a consultant to the general manager of the division. The appointments were made in anticipation of the transfer of the Lexan polycarbonate resin project from the development to the commercial stage.

Dr. Schubert will continue to head the Chemical Development Department until the transfer is effected. A native of Kansas City, Mo., he received his B. S. at the University of Illinois in 1936 and his M. S. and Ph. D. degrees at Pennsylvania State University. He joined General Electric's Research Laboratory in 1942 and was assigned to research work on silicones. In 1945, he became head of the Research Laboratory's Chemical Process Section, leaving that position to join the Chemical and Metallurgical Division in 1955. Dr. Schubert is a member of the Chemists Club, the American Chemical Society and the American Institute of Chemical Engineers.

Mr. Brous, a native of Harrisonville, Mo., obtained his B. S. degree in chemical engineering at the University of Missouri in 1928 and his M. S. degree in organic chemistry in 1929. He joined General Electric in 1949 as marketing manager for the Chemical Division after twenty years with the B. F. Goodrich Co. Mr. Raynolds is a native of Omaha, Neb., and was graduated from Lafayette College in 1920 with a B. S. degree in chemical engineering. He has been with General Electric since 1949, when he became sales manager of the Silicone Products Department at Waterford, N. Y. He has also served as assistant department manager for silicones and as marketing manager for the Chemical Division.

National Gypsum Co. has announced that it has completed the acquisition of **American Encaustic Tiling Co., Inc.**, Lansdale, Penna. Company officials said the acquisition of the ceramic tile producer involved the exchange of one share of National Gypsum common stock for 2.4 shares of American Encaustic.

LETTERS • LETTERS

Readers of ADHESIVES AGE are urged to send their comments and suggestions on the adhesives industry and on this publication to the editor. The "Letters to the Editor" columns will be used for frank and open discussion of industry matters. In this way, we will have a better awareness of individual opinion bearing upon matters of mutual concern. Address your letter to the Editor, ADHESIVES AGE, 101 West 31st Street, New York 1, N.Y.

Forms Two Divisions

Johnson & Jonhson, New Brunswick, N. J., has announced that LePage's has been made a separate division of the company and will establish its administrative headquarters in Metuchen, N. J. Robert J. Mortimer, vice-president of Johnson & Johnson International, has been named president of the newly formed division. The parent company acquired LePage's, Inc., manufacturer of tapes and adhesives, in 1956 and merged the firm with one of its affiliated companies, Permacel Tape Corp. Permacel now also becomes a division of Johnson & Johnson with George C. Reigger, formerly president of Permacel-LePage's, continuing as president of Permacel.

Hodag Chemical Expands

Hodag Chemical Corp., Chicago, Ill., has built new production, laboratory and office facilities as part of the company's major expansion program now underway. Constructed to handle increasing demand for Hodag's surface active chemicals, the new additions have quadrupled space, and doubled the office area. New facilities, including new stainless steel blending tanks and a sonic homogenizer, have also been set up to manufacture silicone antifoams and other silicone products. Expansion plans call for an increase in laboratory personnel and equipment in the new plant as well as increased warehouse space for storage of raw materials and finished products.

Jerguson Gage & Valve Co., Burlington, Mass., has introduced a new, improved type of outside screw and yoke bolted bonnet valve for use with liquid level gages and instruments.

Increases Sales Staff

Organic Chemical Sales Department of Emery Industries, Cincinnati, Ohio, has appointed four new sales representatives including Robert S. Haley, New York office; J. Warren Sackett, Cleveland office; Walter R. Paris, Lowell, Mass., office, and Robert H. Endres, to a newly created territory with headquarters in Pittsburgh, Penna. Mr. Haley has been transferred to the Organic Chemical Sales Department from the Vopcolene Division, for which he served as eastern sales representative prior to its acquisition by Emery earlier this year.

Mr. Sackett was general manager of Bay Rubber & Plastics, Inc., before he joined Emery. A graduate of Ohio State University, Mr. Sackett has also taken graduate work at Case Institute of Technology. He is a member of the American Chemical Society, the Society of Plastics Engineers and the Akron Rubber Group. Mr. Paris joined Emery from Godfrey L. Cabot, Inc., where he was New England sales representative. He is a graduate of Harvard University and a member of the Boston Rubber Group and the Rhode Island Rubber Group and the Society of Plastics Engineers. Mr. Endres was formerly associated with Standard Oil Co. (Indiana). A chemical engineering graduate of the University of Colorado, he is a member of the American Chemical Society and the American Institute of Chemical Engineers.

Sets Personnel Changes

Gene M. LeFave has been named director of research for the Chemical Division of the Coast Pro-Seal & Manufacturing Co., Los Angeles, Calif. At the same time, Russell W. Morey and Charles W. Morgan have been appointed plant manager and technical supervisor, respectively. The efforts of these new appointments will be coordinated under the supervision of L. C. Boller, vice-president of the Chemical Division.

Perkins Named President

Roger T. Perkins has been elected president of the B. B. Chemical Co., Cambridge, Mass., succeeding Russell K. Nash, who has retired as chief executive of the company. Mr. Perkins became associated with the firm in 1929 and was appointed general manager in 1952.

Licenses Japan Firm

U. S. Rubber Co., New York, N. Y., has licensed the Nakanoshima Steel Co., Ltd., a division of Yawata Iron and Steel Co., Ltd., Japan, to use a process for bonding durable and decorative vinyl plastic sheet to metal on a continuous basis. Called the "Marvibond Process", this process is essentially a method for continuously coating metal with semi-rigid plastic sheets to provide an attractive and rugged finish. Once coated, the metal can be formed or fabricated with virtually any metal-working technique, including spot welding, without damage to the plastic facing. The Japanese firm plans to set up a lamination production line at its plant in Osaka, Japan, and has tentatively scheduled operations to begin by late this year or early in 1959. The laminate will be produced in sheet form and will be supplied to fabricators. Japan is the 22nd foreign country in which the vinyl-to-metal laminating technique has been licensed since it was commercially introduced by U. S. Rubber's Naugatuck Chemical Division about four years ago. It has also been licensed to 16 domestic firms.

Realigns Glue Sales

Stauffer Chemical Co., New York, N. Y., has announced that sales of Lustraglue, produced at Woburn, Mass., and formerly handled by the company's Consolidated Chemical Industries Division, will be integrated with Stauffer's Industrial Sales Division. Walter Bangert, who has had 25 years of experience with the Glue Division, has been appointed eastern sales manager for adhesives, with headquarters at Woburn, and will be responsible for the Lustraglue marketing program. Mr. Bangert succeeds Herman Owen, who has retired after 26 years of service with Stauffer.

FMC Divisions Merge

Food Machinery and Chemical Corp., New York, N. Y., has announced that its Ohio-Apex Division, formerly located in Nitro, West Va., has become a part of the Chemicals and Plastics Division of the company. Though production will continue at Nitro, the Division's offices will be located at 161 East 42nd St., New York 17, N. Y. The new telephone number is Murray Hill 7-7400.

Stuck With It

When paperhanger Leo P. Beasley of Omaha, Neb., made a sudden stop in his car recently, the lid came off a five-gallon can of quick-dry paste. "Paste flew all over the front of the car and down my neck," he recalled. "When I pulled into my garage the paste had dried. I was stuck to the front seat." A neighbor boy ran for help. "The little shaver thought I was sick. The kid's mother showed up just as I was taking my pants off," said Mr. Beasley. But the stuck-up paperhanger's troubles didn't end there. "I've been hosing water into the car all morning," he said. "It takes about 400 gallons of water to dilute this much paste."

Custom Drum-Drying

Morningstar-Paisley, Inc., New York, N. Y., has announced that versatile facilities for drum-drying solutions of starches, resins, etc., are now available to chemical processors on a contract production basis. Processor's products can be custom drum-dried and ground to specification at the company's recently acquired Haberland Division, which utilizes exclusive equipment that can manufacture products of various viscosities and concentrations. Manufacturer's ingredients can be mixed or blended before or after the drying operation.

PVAc Unit On Stream

Borden Chemical Co., New York, N. Y., has announced that new facilities for the production of polyvinyl acetate beads are on stream at the company's Illiopolis, Ill., plant. The beads are used by manufacturers of hot-melt adhesives, printing inks, decorative coatings, lacquers and can-lining formulations. The firm also produces PVAc beads in Leominster, Mass.

Hankins Container Co., Cleveland, Ohio has been merged into the **Flintkote Co.**, by agreement reached between officials of both concerns. An exchange of slightly less than 1¼ shares of Flintkote common for each of the 267,458 shares of Hankins capital will be effected by the merger.

Plant Maintenance Show

The Tenth Plant Maintenance and Engineering Show will be held at the Public Auditorium, Cleveland, Ohio, on January 26 to 29, concurrently with the Plant Maintenance and Engineering Conference. Almost 400 companies will have exhibits at the 1959 show, which will demonstrate equipment and products designed to keep plants and machinery in operation. The past decade has seen an enormous increase in the use of automatic high-speed production machinery and the problems of maintenance have increased in proportion. Advance registration cards for the show or conference may be obtained from Clapp & Poliak, Inc., 341 Madison Ave., New York, N.Y., producers of the show and conference.

Cementable Teflon

MW Protective Coatings Division of Metalweld, Inc., Philadelphia, Penna., has introduced a large scale application for "Cementable Teflon", a newly perfected lining material produced by E. I. du Pont de Nemours & Co., Inc. This material imparts an anti-stick and abrasion resistant surface to bulk material handling equipment such as hoppers, feeders, chutes, guide rails and unit containers, and has been used effectively in many types of industry including food and pharmaceutical plants. Cementable Teflon does not absorb water, is non-flammable, resists weathering and has excellent cementability, the company says.

Plans New Paper Unit

Federal Paper Board Co., Inc., has announced plans to open a new folding carton plant on a 37 acre site in Washington, Penna. According to John R. Kennedy, president, carton operations at two other plants will be consolidated at the new facility. The company has seven carton plants and eight paperboard mills.

Constructs New Plant

Union Bag-Camp Paper Corp. is constructing a 50,000 square-foot plant in Glens Falls, N. Y., to be used by the Honeycomb Division of the company. To be constructed on a 10-acre site, the building will be of tilt-up, concrete construction.

Inerto Offers Macaloid

Inerto Co., San Francisco, Calif., has increased the production of "Macaloid", a refined hectorite which is said to have rare and unusual properties. According to the company, this versatile product is easily dispersed in water, will adsorb, purify, flocculate, gel, suspend, stabilize, emulsify and, when spread on a smooth surface, will dry into a strong flexible film with a uniform thickness from 0.001" to 0.002". Similar to bentonite in some of its properties, hectorite substitutes magnesium for aluminum in the lattice structure. Unlike bentonite, which refines into a light tan-colored substance with an earthy odor, Macaloid is almost pure white with no odor and is said to be substantially free of impurities. The company states that Macaloid, which sells at slightly higher cost, will perform any function of bentonite with better efficiency and offers a far wider scope of use for research and industry.

Acquires Match Firms

Sutherland Paper Co., Kalamazoo, Mich., has purchased the Superior Match Co., Chicago, Ill., and the Monarch Match Co., San Jose, Calif., for a total of 60,000 shares of Sutherland common stock, cash and other considerations. Sutherland closed on the New York Stock Exchange on September 30 at 41¾, indicating a value for the stock alone of $2,460,000. The two match companies were owned by Harold and Paul Meitus who will remain as officers with Harold Meitus becoming a Sutherland director. The firms make and sell book matches and the move is Sutherland's first entry into the match business.

Airco Builds New Plant

Air Reduction Chemical Co., New York, N. Y., has started construction of a new 20 million pound per year polyvinyl alcohol resin plant at Calvert City, Ky., and a supporting pilot plant at Bound Brook, N. J. Both projects will cost over $12,000,000 and are expected to be on stream by early 1960. The manufacturing process to be used by Airco was obtained under license from the Kurashiki Rayon Co., Ltd., Osaka, Japan. Polyvinyl alcohol is used in this country in the preparation of adhesives, textile sizings and finishes, paper coatings, and as emulsifying and thickening agents.

John H. Field

Portrait Of

John H. Field

Mr. Field, who recently joined the Editorial Advisory Board of ADHESIVES AGE, as announced in the October, 1958, issue, earned his A.B. degree in chemistry from Dartmouth and immediately thereafter started work with the B. F. Goodrich Co. as a chemist in the general laboratories. The next year he transferred to the research laboratories. In 1944, he was named technical manager of the B. F. Goodrich Chemical Co. development laboratory.

In the latter part of 1945, he accepted a position as general manager of Plastipos S. A. in Mexico City. Early in 1950, Mr. Field returned to the United States to take over the Extrusion Department at the Decatur, Ill., plant of the General Electric Co. In March of 1950, he became general foreman of the Decatur plant responsible for all manufacturing and tool-making operations.

Mr. Field rejoined the Goodrich organization in 1952 in a new department specializing in the manufacture and development of rigid plastics products. His present position with Goodrich dates from 1954 and includes technical direction of departments which manufacture solvent adhesives, adhesive bonding film, coated fabrics, and latex and plastisol mixes.

He is a member of Plastics Engineers, the American Chemical Society and the Adhesives Manufacturers Association. He is also an alternate member of the Vinyl Dispersions Division of the Society of the Plastics Industry.

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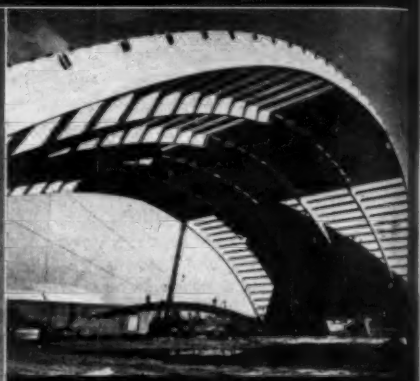
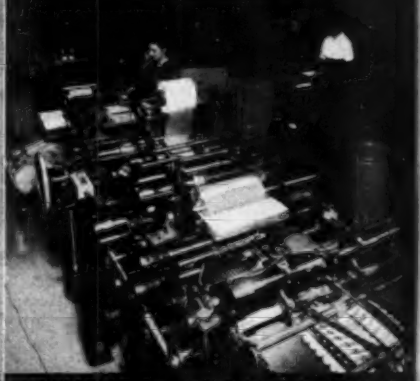
ADHESIVES ⇨ ⇨ NEW MARKET

PLANES: Adhesive bonding materials are vital components in the construction of today's high-speed military and commercial transports. More than 800 pounds of adhesives literally hold together this new jet-airliner. (Douglas Aircraft Co.)



BUILDINGS: More than 10,000 pounds of adhesives were used in construction of this Arena. Structure, now completed, includes among its components, ten 250-foot glued laminated endwall ribs; 23 glued laminated columns and 12 glued laminated beams. (Borden's)



ENVELOPES: New, controlled-viscosity glassine window gums are used to speed production of envelopes . . . produce flat windows with strong adhesion on standard and high-speed window and patching machines. (Morningstar-Paisley, Inc.)

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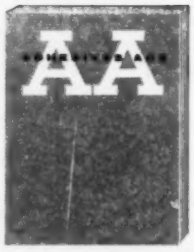

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ADHESIVES AGE NEW MAGAZINE

News Briefs

Hercules Powder Co. has announced a more stable pricing policy for pale grades of wood resins of its Naval Stores Department. Effective October 1, prices will be quoted firm for three months, and will be subject to change quarterly.

Norge Division of Borg-Warner Corp. has added 600 workers and has started second turns at three of its appliance plants in an effort to meet unfilled orders and refill depleted inventories. Norge officials said July and August sales were up 19 per cent from last year and were the highest for this two-month period in the company's history.

Chase Bag Co. has purchased the polyethylene film extruding machinery and processes of **Plax Corp.**, Hartford, Conn., for an undisclosed price. Plax, which is owned jointly by **Monsanto Chemical Co.** and **Emhart Manufacturing Co.**, will continue to manufacture plastic squeeze bottles and oriented styrene sheet and film.

Kontes Glass Co., Vineland, N. J., has added small reaction flasks to the Bantam-ware line of small organic glass apparatus. Available in interchangeable top and bottom flask sections, the company said one section can serve as a common component for six different flask assemblies in the range of 50 ml. to 500 ml. capacity.

Robinson Ventilating Co. of Zelienople, Penna., has introduced a new, heavy duty industrial "man cooler" oscillating fan which should have wide application along production lines and in areas where excessive heat conditions tend to reduce employee efficiency.

Schutte & Koerting Co., Cornwells Heights, Penna., has announced a new line of "Atomizing Nozzles" for general service in operations where liquids in quantities of less than 3 gpm are to be sprayed as fine mists.

C-Mar Corp., 35 Euclid Ave., Manasquan, N. J., has made available a new area-type flow meter that is said to measure accurately flow rates with new standards of float stability.

American Machine Products Inc., New York, N. Y., is producing centrifugal and neoprene-impeller type pumps that are corrosion resistant with sealed ball bearings, and have shafts, bodies and covers made of acid-resistant Type 20 stainless steel.

Foxboro Co., Foxboro, Mass., has announced an absolute pressure transmitter that is accurate to 0.5 per cent of full scale. A force balance instrument, the new transmitter produces a 3 to 15 psi linear signal proportional to absolute pressure.

Standard Packaging Corp. has approved plans to merge with **Eastern Corp.** of Bangor, Maine. Under the terms approved, Standard will exchange eight-tenths of a common share and one share of its new cumulative convertible preferred for each Eastern Corp. common share.

Corn Products Refining Co. has approved a plan for the conversion of preferred stock into subordinated debentures as part of a proposed merger with **Best Foods, Inc.** Under the plan, each share of 7 per cent preferred stock would be converted into $175 of 4¾ per cent debentures due October 1, 1983. The debentures would be non-callable until October 1, 1978.

Marbon Chemical Division of Borg Warner has moved its general sales office, research labs, and general administrative departments into a new center built as part of the Woodmar Plant, Washington, West Va. The $12 million Woodmar facility, which was completed about a year ago, makes high impact acrylonitrile-butadiene-styrene tripolymer.

Catalin Corp. of America will make acrylic polymer emulsions and solutions for coatings and adhesives under a 10-year-license agreement with Union Chimique Belge, S. A. (Brussels).

United States Plywood Corp. has begun marketing the entire fir plywood production of the **Pacific Coast Co.** The arrangement involves the production of the Pacific Coast mill at Sonoma, Calif., which has a capacity of 36,000,000 square feet a year.

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names in the news

Robert C. Gilardi has been appointed Chicago district manager in charge of midwest sales activities for Air Reduction Chemical Co. **Patrick C. Duffy**, who joined Airco this year, will assist him. Other Airco appointments are **Roger C. Schmalfuss**, West Coast representative; **William F. Lehr**, Southeastern and Middle Atlantic states, and **Charles T. Law**, New York and New England.

Gene M. Le Fave has been named director of research of the Chemical Division of the Coast Pro-Seal & Manufacturing Co., Los Angeles, Calif. At the same time, **Russell W. Morey** was named plant manager and **Charles W. Morgan** was appointed technical supervisor.

Allan E. Settle, has been named director of public relations of the Manufacturing Chemists' Association, Washington, D. C., succeeding **George M. Worden**, who has resigned.

Frank Farkash, who was technical assistant manager, has been named to the position of assistant plant manager of the Jersey City, N. J., sodium silicate plant of the Diamond Alkali Co.

William P. Katz, vice-president and one of the principals of the Gibralter Corrugated Paper Co., has been named to head up the Display Division, succeeding **S. Paul Boochever. Donald E. Stare** has joined the Inland Manufacturing Division of General Motors as an adhesives chemist.

Richard Anderson has been appointed field engineer for antifoams, flocculating agents and other surface-active agents in the Wisconsin, Minnesota and parts of Michigan and Iowa territory of the Hodag Chemical Corp.

Fred T. Wilson, Jr., has been appointed manager of the New Orleans sales office of the Air Reduction Co., while **E. C. Kennedy** has been named to succeed him as assistant sales manager.

G. S. Kennedy has been elected to the newly created position of executive vice-president of General Mills. **E. O. Boyer** succeeds Mr. Kennedy as vice-president and administrator of the Flour, Feed & Oilseeds Operations. At the same time, **B. W. Roberts** was named general manager of the Sperry Operations in the Western states.

Dr. Wesley D. Schroeder, formerly industrial chemicals research supervisor, has been promoted to manager of product research for activated carbon and industrial chemicals, in the Research & Development Department of Pittsburgh Coke & Chemical Co.

Roger E. Caffier has been named chemical sales representative in the Cleveland, Ohio, area for the Plastics and Coal Chemicals Division of the Allied Chemical Corp.

Obituaries

Marvin O. Shrader

Dr. Marvin O. Shrader, supervisor of organic chemical research for the Research & Development Department of the Pittsburgh Coke & Chemical Co., Pittsburgh, Penna., died suddenly on September 21 at the St. Clair Memorial Hospital. Born in Bishop, Va., Dr. Shrader received an A. B. from Berea College in 1937, an M. A. from Syracuse University in 1939 and a Ph. D. from Yale University in 1942. Previously associated with the General Aniline & Film Corp., he joined Pittsburgh Coke in 1952. Dr. Shrader was a member of the American Institute of Chemists; the American Chemical Society; Alpha Chi Sigma; Sigma Xi, honorary scientific fraternity; the American Association of Textile Chemists and Colorists, and the New York Academy of Science. He is survived by his wife, a son and a daughter.

St. Regis Expanding

The St. Regis Paper Co. is expanding its paper converting and container business through the acquisition of the F. J. Kress Box Co., Pittsburgh, Penna. The companies merged on the basis of an exchange of 2¼ shares of St. Regis common for each share of Kress. The latter has 128,200 shares of capital stock. Kress Box manufactures corrugated and fiber shipping containers and operates plants at Pittsburgh; Newark, Ohio; Washington, Penna; and Hagertsown, Md., and employs about 900 persons at the various company facilities.

Brewer Named President

Gene C. Brewer has been elected president of the United States Plywood Corp., New York, N. Y., succeeding S. W. Antoville, president since 1953. Mr. Antoville has been elected chairman and chief executive officer. The office of chairman had been vacant since the death of Lawrence Ottinger, the company's founder, in 1954. Mr. Brewer was formerly vice-president in charge of West Coast operations. He joined U. S. Plywood in 1937, was elected a vice-president in 1954, and has been a director of the company since 1956.

Adhesive for Printers

Adhesive Products Corp., New York, N.Y., announces the development of a powerful adhesive, "Doublegrip." The new adhesive was developed for adhering rubber mats to printing cylinders. The adhesive is applied to both the rubber mat and the cylinder and allowed to dry for a few minutes. When dry, the rubber mat adheres tenaciously on contact, company officials state.

Borden Appoints J. F. Day

Appointment of John Franklin Day as West Coast sales representative for the consumer products department of the Borden Chemical Co. has been announced. Mr. Day will make his headquarters in Los Angeles, where he has been associated with Joseph T. Ryerson & Son, Inc., Fortifiber Corp., as well as the U. S. Borax & Chemical Corporation.

Maher Addresses Thiokol Technical Club

Approximately two hundred guests at the semi-annual meeting of the Technical Club of the Thiokol Chemical Corp., Trenton, N. J., heard D. W. Maher, Merchandising Manager of the Minnesota Mining & Manufacturing Co., outline the new characteristics of adhesives and the vast future growth possible in this field.

"Adhesives have already been successfully adapted by the aircraft industry," Mr. Maher stated, "in order to obtain the high structural strength, lightweight, smoother joints, and strong bonding necessary for supersonic aircraft. It is obvious that the building, marine and automotive industry can adopt some of these techniques to introduce improved design, improved performance, and lower cost production."

Mr. Maher visualized as part of the coming markets in the building industry the use of adhesives in reducing construction costs. Preformed roofs, the use of translucent wall panels, improved dry wall application techniques to eliminate the time consuming taping required, strong inexpensive sandwich panels, and many other items, he felt, would make inexpensive, structurally improved residential homes a reality.

Defines Adhesives

In defining adhesives, Mr. Maher outlined the wide range of adhesives now available—the 100% solid liquid form that has no volatility and is dimensionally stable—the two-part systems that are dormant until accelerated by heat, strong contact bonding types, and high structural strength laminates. One of the new developments Mr. Maher elaborated on was the new liquid form adhesive that bonds when oxygen is excluded. This adhesive is now being used to coat threads on screws. The possibilities behind this strong fastening method seem enormous.

Development of these vast markets depends on several factors Mr. Maher stated. One is the education of engineers and designers so that they can allow for the type joints where adhesives are most effective. Another is the competition among processors in the field to market these developments successfully so that the vast number of industrial prospects are thoroughly covered.

H. L. Dixon

Officers Re-Elected

Rubber & Plastic Adhesive & Sealant Manufacturers Council re-elected H. L. Dixon (B. F. Goodrich) as president of the organization at a meeting held on September 10 to 12 at the St. Clair Inn, St. Clair, Mich. Also re-elected were L. R. Turner (St. Clair Rubber) as first vice-president; N. L. Melbye (Angier Adhesives) as second vice-president and J. L. Been (Rubber and Asbestos) as third vice-president. B. F. Warmer (Coast Pro-Seal) was named treasurer. The officers, who will serve through September, 1959, were also elected to the organization's Steering Committee along with F. M. Jeffe (Pierce & Stevens) and C. W. Walton (Minnesota Mining). The Council's next meeting has been scheduled to be held on December 8 and 9 at the Shoreham Hotel, Washington, D. C.

Mr. Maher has been with 3M since his graduation from the University of Minnesota in 1934. He served in administrative capacities until 1945 when he was assigned to the Adhesives, Coatings and Sealers Division in Detroit. There he served as assistant to the vice-president, as a National Sales manager for industrial products, as a Private Label Account Executive and as the Merchandising Manager for the Division.

The speaker was introduced by Dr. S. M. Martin, Jr., General Manager of Thiokol's Chemical Division.

Ohio Boxboard Co., Rittman, Ohio, is producing corrugated bulk shipping containers that hold up to one ton of dry, free flowing materials. Called "Pillar-Pac," these new patented containers hold as much material as 40 fifty-pound bags.

C. M. R. A. Fall Meeting To Highlight Adhesives

Several hundred chemical industry executives representing United States and Canadian companies are expected to attend the fall meeting of the Chemical Market Research Association, to be devoted to "Adhesives," which will be held on November 12-13 at the St. Paul Hotel, St. Paul, Minn.

The nature and size of the markets for adhesives and future trends will be discussed at the meeting by R. F. Blomquist (U. S. Department of Agriculture); D. W. Maher (Minnesota Mining), and R. E. Smith (H. B. Fuller).

Market Shop Panel

A special feature of the meeting will be the "Market Shop" at which panels will discuss actual case histories of the methods of marketing research leading to the commercialization of new products in the fields of adhesives, polyethylene, fluorocarbons and epoxy resins.

Speakers and critique panelists for the Market Shop will include W. H. Bromley, Jr. (Shawinigan Resins); J. C. Hoopes (DuPont); A. Jonnard (Shell Chemical); E. W. Segebrecht (Spencer Chemical); S. D. Koonce (American Cyanamid); W. L. Machmer, Jr. (Allied Chemical); Frank Murphy (National Starch); P. W. Wood (Union Carbide), and H. W. Zabel (Roger Williams Technical & Economical Services).

The dinner session will be highlighted by talks by Harry A. Stuhldreher (U. S. Steel) and Dr. L. M. Gould (Carlton College).

Studies Market

The Chemical Market Research Association is a national organization of 600 chemical industry executives. The scope of its activities encompasses work on many phases of the practical economic aspects of the chemical business. It includes the determination and evaluation of all pertinent facts concerning markets and marketing methods.

Executives attending the Twin City meeting of C. M. R. A. will include professional economists, general managers, and marketing and research managers. Upper Midwest members of the A. C. S., A. I. Ch. E., A. I. C., and other allied organizations have been invited to attend the meeting.

patent review

By MELVIN NORD

Degradation of Starch

U.S. Patent 2,833,759, issued May 6, 1958 to Kenneth C. Hobbs, Ralph W. Kerr, and Francis E. Kite, assigned to Corn Products Refining Co., describes a process for the degradation of starch and starch derivatives with oxygen in the presence of hydrated lime. The object is to reduce the viscosity of the starch or derivative, i.e., to render it "thin boiling."

The present invention is based on the discovery that when an aqueous slurry of starch or of a starch derivative in granular form or a starch paste, each containing hydrated lime, is exposed to air, oxygen is consumed and degradation of starch proceeds very rapidly. Both the rate and degree of degradation can be controlled by control of temperature, alkalinity, and air supply.

Sodium Silicate Adhesive

U.S. Patent 2,834,744, issued May 13, 1958 to James G. Lander and assigned to Diamond Alkali Co., discloses an aqueous sodium silicate adhesive. Its composition is as follows:

	Per Cent
Aqueous Silicate glass solution ($Na_2O:SiO_2$ ratio 1:2.5-4, 35 to 47% solids	70-85
Urea	2-8
Piccopale Resin	0.1-2
Water	Balance

Water-Resistant Adhesives

U.S. Patent 2,836,574, issued May 27, 1958 to Gordon E. Brown and assigned to Monsanto Chemical Co., discloses water-resistant hot-setting adhesive compositions.

The adhesive compositions consist of aqueous solutions of 100 parts of a water-soluble urea-formaldehyde condensate, from 75 to 200 parts of a melamine-formaldehyde condensate, and an acidic curing catalyst.

The urea condensate is prepared by heating at reflux temperature and atmospheric pressure one mol of urea with 2 to 2.5 mols of formaldehyde, starting at a pH of 7 to 8. A condensate containing a preponderance of methylol groups as compared to methylene bridges is produced.

The Author

Melvin Nord

The melamine condensate is prepared by reacting one mol of melamine with 2.3 to 2.7 mols of formaldehyde at a pH of 8 to 9 at reflux temperature and atmospheric pressure. A condensate is produced which is soluble in water only in concentrations above 25% solids by weight.

Water-Soluble Adhesive Tape

U.S. 2,838,421, issued June 10, 1958 to William E. Sohl, assigned to Minnesota Mining & Manufacturing Co., describes an adhesive tape characterized by a novel water-soluble adhesive coating that is aggressively and normally tacky and hence does not require activation by water, solvents or heat at the time of use. The adhesive adheres with a strong holding force when the tape is pressed against objects having a hydrophilic surface, such as paper, cloth, glass, metal and wood, without the need of more than finger or hand pressure.

The adhesive is water soluble. It is insoluble in and is not swelled by gasoline, oils and hydrocarbon solvents. It adheres to damp or moist surfaces but not to oily surfaces. It appears to be only slightly tacky when tested by touching with the fingers since these normally have a film of oil on the surface of the skin. However, it is properly termed a normally tacky adhesive since it sticks upon contact with a variety of common materials, as noted above.

This adhesive tape is fundamentally different from the well-known "pressure-sensitive" adhesive tapes, which have a water-insoluble rubber-resin type of adhesive coating that is permanently and aggressively tacky, and are strongly tacky when touched with the fingers. It is water-insoluble and hydrophobic and does not adhere to damp or moist surfaces. The ordinary types are soluble in and swelled by gasoline, oils and hydrocarbon solvents, and in fact are commonly coated in solution in a hydrocarbon solvent, such as heptane.

Despite the fact that it is soluble in water, the adhesive coating of the tape retains its cohesive and tacky state when exposed either to dry or humid atmospheric conditions. It does not dry out and lose tack even in an anhydrous atmosphere, nor does it become soft and pasty even in a highly humid atmosphere.

Colloidal Systems

U.S. 2,837,438, issued June 3, 1958 to Thomas E. Sample, Jr., and assigned to Monsanto Chemical Co., relates to colloidal systems of cyanoethylated starch, water, and water-miscible low molecular weight aliphatic ketones, and the use of such systems for impregnating cloth and paper.

It has been found that while cyanoethyl ethers of starch containing 1.5 to 2.0 cyanoethyl ether groups per glucose unit cannot be colloidally dispersed in water, or in low molecular water-miscible aliphatic ketones, a colloidal sol of such starch ethers can be prepared using a mixture of water and such ketones.

Paper Size

U.S. 2,837,439, issued June 3, 1958 to Judson S. Swearingen and Lubertus Bakker, assigned to Sinclair Refining Co., relates to the manufacture of novel compositions useful as sizing materials for paper.

It has now been found that aqueous emulsions of partially saponified rosin and aromatic petroleum lubricating oil extracts of certain characteristics in which a particular amount of free rosin is present provide excellent paper sizing compo-

sitions which reduce the permeability of the paper to liquids and effectively bind the paper fibers. The emulsions are characterized by the presence of at least 0.4 parts of saponified rosin per part of aromatic extract, by the presence of 5 to 8.5 weight per cent of free rosin based on the original rosin present, and by the use of aromatic extracts of particular physical characteristics (aniline point not more than 60°C., API gravity 6.0 to 16.0, flash point not less than 375°F., viscosity 400 to 35,000 SUS at 100°F. and 50 to 300 at 210°F., and molecular weight 250 to 500).

The emulsions can be produced in concentrated form thus avoiding the shipment of large quantities of water. The emulsions provide substantial economic advantage in that expensive rosin can be partially replaced with a petroleum product that is readily available.

Bonding Polyethylene Surfaces

U.S. 2,838,437, issued June 10, 1958 to Warren F. Busse and John A. Boxler, assigned to E. I. du Pont de Nemours & Co., discloses the fact that polyethylene and other monoalkene polymers can be made to adhere more readily to other surfaces by having present in them a modifier of one of the following types:

(1) Carboxylic acids having alpha-beta olefinic unsaturation and having hydrogen attached to the alpha carbon atom, e.g., fumaric acid,

(2) Anhydrides of these acids,

(3) Carboxylic acids having alpha-beta acetylenic unsaturation,

(4) Malonic acid,

(5) Mono- and di-alkyl and alkenyl esters of the above acids—(up to 6 carbon atoms), e.g., diallyl fumarate, and

(6) Salts of the above acids.

The modifier may be introduced as such into the polymer or formed *in situ* from precursors. The modifier or precursor may be applied to the polyethylene surface, or to the surface to be adhered to it, or may be milled into the polymer, or mixed with the polymer during extrusion, or incorporated in the polymer in other ways.

An important application is the bonding of polyethylene to metal, especially aluminum, copper, brass, tin, or galvanized iron. Another use is in improving the tensile strength of filled polyethylene containing such fillers as carbon, titania, clays, silica and whitings.

One of the most important applications is in the manufacture of tear-resistant laminated films which can include aluminum foils, cellophane, or nylon film, bonded to polyethylene film. This permits control over permeability by using combinations of lamina which provide barriers to various materials such as water, oils and acetic acid.

Fabric-Rubber Adhesions

U.S. 2,839,443, issued June 17, 1958 to John J. Fleming and assigned to United States Rubber Co., describes a method of adhering butyl rubber to textile fabric, as in tires.

The invention is based on the discovery that butyl rubber can be adhered to textile fabric with the aid of an adhesive consisting of butyl rubber that has been subjected to a partial vulcanization treatment and thereafter mixed with a phenol-formaldehyde resin.

Other Patents of Interest

Subject	Inventor or Assignee	Patent No.	Date
Sealing putty for use as barrier against injurious radiations from atomic energy	Knapp Mills Inc.	2,833,664	5/6/58
Elastic insulating tape	Phillips Petroleum Co.	2,834,742	5/13/58
Composite tape having controlled bonding and release properties	Philip N. Braun, Inc.	2,835,621	5/20/58

Copies of any patents, including those described here, are available from the Commissioner of Patents, Washington 25, D. C., for 25 cents each. Do not send stamps.

Adhesives vs. Screws

Adhesives originally developed for the aircraft industry are being substituted for conventional metal screws in the mass-assembling of aluminum screen doors. According to an announcement from Francis Brothers Corp., Tustin, Calif., the new adhesives have not only enabled them to turn out stronger, more attractive units, but have significantly cut production time by eliminating tapping and drilling operations previously required for screw holes.

In this new assembly technique, side and top rails are accurately cut with 45 degree bevels from hollow extruded aluminum stock. The corners are assembled by coating an especially shaped aluminum extrusion section with Narmco Formula 3135 adhesive, and fitted into the rails at the corner joint. The doors are then stacked without camping, and the adhesive is allowed to cure.

Six Aminco Offices

The American Instrument Co. of Silver Spring, Maryland, has opened new sales offices in New Jersey, New York, Ohio, Michigan, Colorado and California. The offices are staffed by trained personnel handling the sale of the company's entire line of precision instruments.

Sperry Sells Bindery

Sperry Rand Corp. has announced the sale of its Bindery Department at the Remington Rand Division plant in Benton Harbor, Mich., to the American Loose Leaf Corp., Clifton, N. J. The sale involved manufacturing equipment, raw materials and supplies. The company stated that other operations at Benton Harbor were not affected.

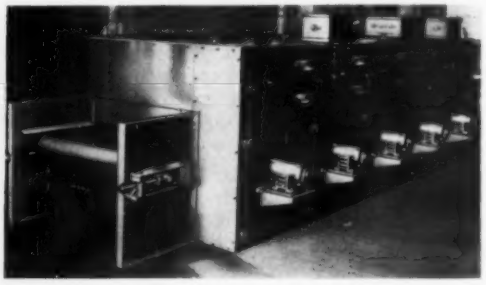
Aluminum Foil Posters

Introduction of aluminum foil sheeting with special perforations has brought about a new trend in billboard posters. Previously, the use of aluminum foil was impractical because paste would not dry under the vapor-proof foil. The new perforated foil permits the use of standard billboard paste.

new equipment

Pilot Plant Dryer

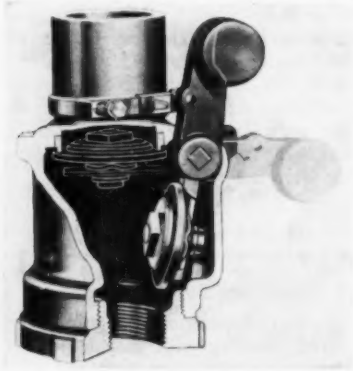
A pilot plant model dryer designed to fill the gap between laboratory and production line has been field tested and plant proven in a number of installations. Small enough to be used in the laboratory, the dryer has sufficient capacity for seasonal or auxiliary production work. It can be manufactured with any number of sections of aluminum, stainless steel or other materials. The versatile unit fills a need for a pilot plant dryer capable of quality work on products with widely varying drying requirements. Dimensions are 3 by 4 feet. *C. G. Sargent's Sons Corp.* E-9



Sargent pilot plant dryer

Safety Valve

The OPW-Jordan No. 10 safety shut-off valve is constructed to close automatically in case of fire or accidental bumping by shutting off the flow of volatile liquids and thus preventing or starving the fire. The valve, which is made of cast iron with a nitrile rubber disc for tight shut-off, is available in 1-, 1¼- and 2-inch sizes. Originally developed for gasoline pumps, the valve is now available to general industry. *Jordan Industrial Sales Division, OPW Corp.* E-10



Safety shut-off valve

Continuous Processing Machine

A continuous processing machine, which combines continuous mixing with accurate process temperature control, is capable of transferring heat to or away from materials as it mixes. Because of the multiple action of the Flowmaster, as the machine is called, it can be used for emulsifying, cooling and heating. The design consists of a series of fixed heat transfer plates through which a heat transfer fluid may be circulated, or the plates may be direct electrically heated. Spaced between each heat transfer plate are beaters mounted on a common shaft. These beaters intensively mix, in a relatively small volume, the material flowing through the channels of each plate. The machine is built with maximum working pressures up to 350 psig and operating temperatures from 32 to 400°F. Special machines may also be manufactured. *Chemical Machinery Division, Baker Perkins, Inc.* E-11

Paper Thermometers

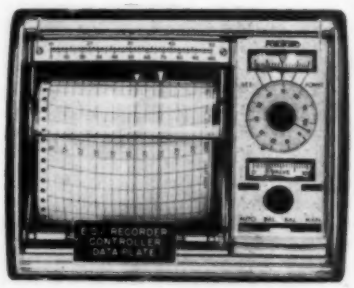
Thermopaper and Thermotube disposable paper temperature indicators are now available for measurement of temperatures of 100, 105 and 110°F. The new indicators supplement those in the previously offered range of 115 through 490°F. The indicators measure temperature by exhibiting an irreversible color change when subjected to predetermined temperatures. Speed of response is said to be faster than one-tenth second and accuracy to be within one per cent of the rated temperature. Applications in the adhesives field include measurement of temperatures in hot seal adhesive equipment and in plywood and film laminating. *Paper Thermometer Co.* E-12

Safety Can

A new oval-shaped 5-gallon safety can is said to require much less space and be much easier to handle than the standard round safety can. Flexible pouring spouts eliminate hazardous spillage when dispensing, and permit filling of containers through small receiving openings without waste. The body is constructed to withstand heavy usage. *Protectoseal Co.* E-13

Electronic Recorders

New one- and two-pen electronic recorders, called Model 64, with full 4-inch strip charts are available as part of a new line of electronic control instruments. Designed for economy of panel space, the instruments feature slide-out chassis with stretch-out cord which permits the unit to be withdrawn without interruption of service. A powerful deflection motor drives the recording pen; no additional amplification is necessary. All instrument adjustments can be made without interrupting the instrument circuit. *Foxboro Co.* E-14



Foxboro electronic recorder

Hand Sealant Gun

A new lightweight sealant gun is said to speed operations and lower costs. Especially useful for field service work, the new sealant tool is adaptable for use with such industrial caulking compounds as aircraft, automotive, marine, construction and electrical sealants. The sealant is extruded by means of a squeeze of the trigger. Made of solvent resistant reinforced plastic, the gun uses disposable polyethylene cartridges, plungers and nozzles. Standard disposable cartridges, which are changed in only a few seconds, are available in 2½- and 6-ounce sizes. *Semco Sales and Service, Inc.* E-15

Semco hand sealant gun

Adhesion Test Apparatus

The climbing drum peel apparatus is an accessory for tensile testing instruments. The unit is primarily intended for determining the comparative peel resistance of adhesive bonds between relatively flexible facings and cores of sandwich construction. With a modified specimen, the apparatus can be used for determining the comparative peel resistance of adhesives in laminated assemblies where at least one adherent is flexible enough to bend smoothly over the surface of the drum. *Custom Scientific Instruments, Inc.* E-16

Weighing-Filling Machine

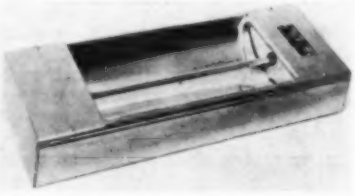
A new inexpensive bench model weighing and filling machine for free-flowing materials operates by gravity flow, needs no motor, and delivers 18 to 20 accurate weighings per minute, according to the manufacturer. Designated Holm Model GF, the unit is designed for small-scale packaging operations involving free-flowing materials. Capacity is up to five pounds. *Richardson Scale Co.* E-17

Quick Release Valve

A quick release valve for faster, more efficient air-pressure venting of cylinders and other pneumatic devices is said to offer the following advantages: (1) great capacity provided by large internal air passages; (2) great sensitivity, as pressure can be vented in increments of approximately 6 psi; (3) reduced weight, as the instrument is built of aluminum and weighs only 7 ounces. The valve is said also to possess mounting flexibility, long operating life and quiet operation, and to be unaffected by rotation. *Industrial Products Division, Westinghouse Air Brake Co.* E-18

Infra-Red Oven Sections

Extreme versatility and efficiency in both physical and electrical characteristics are said to be featured in infra-red oven sections, designated R-600, for radiant heating, drying and baking applications. The unit's aluminum housing and reflector have been designed to utilize efficiently a special quartz-enclosed nichrome heating element. This gasless heating tube emits radiation at a wavelength of 2.3 microns, which is claimed to be the length of wave most completely absorbed by water, solvents and many industrial materials, and therefore most effective for heating, baking and drying. The element produces very little visible radiation, eliminating glare and loss of energy in the form of light. *Lighting Division, Safety Industries, Inc.* E-19



R-600 infra-red oven section

FOR MORE INFORMATION on the new equipment items described here, use the Reader's Service Card elsewhere in this issue.

Isobond 321 Adhesive

A new one-part 100 per cent epoxy adhesive, designated Isobond 321, has been announced by the Isochem Resins Corp., Providence, R. I. The high-strength adhesive is said to offer all the beneficial qualities of epoxy bonding material, and yet eliminates time-consuming mixing, weighing and metering.

A true thixotropic paste, it can be applied to any surface, including vertical ones, without sagging or running. A short heat curing is required to form a bond which is stable at 200°C., or even higher under certain circumstances.

The manufacturer points out that as a 100 per cent epoxy, Isobond 321 has excellent adhesion to metals, ceramics, glass, cement and other temperature-stable materials. It offers high chemical resistance to most fluids.

Diamond Alkali Earnings

Third quarter 1958 earnings of Diamond Alkali Co., Cleveland, Ohio, were nine per cent higher than for the same period in 1957, even though sales were eight per cent lower, according to Raymond F. Evans, chairman and president.

Third quarter earnings totaled $1,624,927, or 58¢ per share, as against $1,532,584, or 55¢ per share, for the second quarter income. Sales in the July-August-September period amounted to $28,133,627.

"This reversal of the usual relationship between fluctuating sales and earnings," Mr. Evans pointed out, "resulted chiefly from our intensified cost reduction and profit improvement efforts which should prove even more effective as volume increases."

Technical Translations

Translations of Soviet technical literature will now be available to American science and industry from the recently established Foreign Technical Information Center of the U. S. Dept. of Commerce. In addition to publishing translated abstracts of all articles appearing in 141 Soviet technical journals, the new center will make available translations of important sections of Referativny Zhurnal, an abstract journal, and a semi-monthly review of Soviet scientific activity compiled by the Central Intelligence Agency.

Complete information can be obtained from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.

book reviews

Dispersion of Materials. ***By Rolt Hammond. Published by Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. 5½ x 8¾ in. 230 pp. $10.00.***

This book, the second volume in a series with the over-all title, "Physical Processes in the Chemical Industry," deals with a subject of direct interest to the adhesives manufacturer. The dispersing of materials is a problem which prevails in many of his production processes, and one whose efficient handling is an important economic factor. The author has presented both theoretical and practical information, so that the reader who studies his work will gain not only a knowledge of what happens, but also why and how.

The book is divided into six chapters: (1) Crushing and Grinding, (2) Classifying Materials (3) Fluidization, (4) Flotation, (5) Liquid Dispersions and (6) Dispersion of Gases and Atmospheric Pollution. The first two chapters make a thorough examination of the principles and practice of crushing, grinding and classifying materials, including special methods for the processing of very hard and other difficult materials. Extensive data on different machines and processes are presented. In the chapter on fluidization the author discusses an increasingly important process with its industrial applications, advantages and limitations.

In the pages on flotation he analyzes froth flotation, chemical promoting agents, extraction of base metals, flotation machines, flotation in the chemical industry and other subjects. The chapter on liquid dispersions covers solutions, emulsions, emulsoids, gels, coagulation, homogenization and related topics. The last chapter contains information on the dispersion of gases and atmospheric pollution.

At the end of each chapter a list of literature references is given, and also presented is a list of commercial firms (most of which are English) which manufacture products or machinery of interest. Schematic diagrams and photographs are used to good advantage in telling the story of how materials are dispersed. Subject and author indexes close the volume.

The manufacturer of adhesives, and his technical personnel, will find data of interest here. The chapter on liquid dispersions is to be noted as of special interest. This volume is a valuable textbook for students entering the chemical and chemical engineering industries and also serves as a useful reference book.

Vinyl Resins. ***By W. Mayo Smith. Published by Reinhold Publishing Corp., 430 Park Avenue, New York 22, N. Y. 5¼ x 7¾ in. 282 pp. $5.75.***

This book is part of a series of short volumes on the various plastics materials, their applications and fabrication processes. The book is semi-technical—one does not have to be a chemist to understand the material, and indeed its major appeal will probably be to those non-technical people who have need of a comprehensive knowledge of vinyl resins.

There are six chapters: (1) Scope of the Vinyls, (2) Types and Properties, (3) Chemistry, (4) Manufacture and Fabrication, (5) Applications and (6) New Developments. In these chapters are presented a great number of data on consumption, production techniques, and especially on applications and end uses.

Five pages are devoted to adhesives. Most of this space is given to polyvinyl acetate emulsions and their properties, uses and advantages in adhesives for specified purposes. Also discussed are vinyl butyral and vinyl pyridine latex adhesives.

This book fills a need for a source on information on vinyl resins which is exact and up-to-date, comprehensive, with extensive technical data on manufacture and properties of the end products. A good balance between technical and semi-technical coverage has been achieved. The presentation is excellent, and the illustrations of high quality are attractively displayed.

Establishing a New-Product Program. ***(Management Report No. 8). Published by Marketing Division, American Management Association, Inc., 1515 Broadway, New York 36, N. Y. 6 x 9 in. $2.00 (members); $3.00 (non-members).***

Under the pressure of today's powerful competition, many companies are in danger of weakening their market positions unless they have definite, formalized programs for remaining sensitive to customers' product needs. The papers of which this volume is comprised were presented at a conference sponsored recently by the Marketing Division of the American Management Association to evaluate this danger, and to examine what is currently being practiced to cope with it.

The book is divided into three parts. The first, on basic considerations, deals with such subjects as developing sound company policies, pricing new products and legal considerations. The second, on organizational approaches, considers such factors as the new-product development manager and the organization of a new-business development division.

The third part deals with marketing research, a factor which is becoming increasingly important in the planning of today's industrial enterprises. Three aspects are considered: (1) determining what the customer wants, (2) determining the size, nature and location of the potential market, and (3) analyzing competitive factors. Each of these is discussed in relation to both industrial and consumer goods.

The sponsors of the conference assembled an able roster of experts who together present an excellent survey of a field which is assuming ever greater justification as the costs involved in developing and launching new products go higher. Much thought-provoking material is presented.

Trade Literature

Rotary Batch Mixers. This four-page specification sheet offers data on several models of rotary batch mixers designed to mix materials of varying specific gravities or in minute or trace quantities. The mixing principle described in the bulletin is said to offer fast, accurate blending without reduction of particle size of ingredients which are tumbled, turned, cut and folded. Special features, such as an internal spray pipe for introduction of liquids and a door design which provides accessibility for cleaning and inspection, are described. Sizes and dimensions are detailed. *Munson Machinery Co.* L-9

Epoxy Resins. This 8-page brochure, which presents a comprehensive summary of the uses of epoxy compounds in various industries, has three major divisions covering coating and adhesion, plastic tooling, and plotting and impregnating. Each section indicates the types of Maraset epoxy resins available for specific purposes described. Physical properties and characteristics making these materials suitable for the specific applications are highlighted. *Marblette Corp.* L-10

Liquid Antifoams. Information sheet on PV-45B and PV-48, two new liquid antifoams which find application in the adhesive, paint, wall paper and pulp and paper industries. They are also used to prevent foaming of emulsion coatings based on acrylics, latex, polyvinyl acetate and others. *Hodag Chemical Corp.* L-11

Structural Sealing. Elastomeric sealants for all types of building applications are presented in this brochure, which features in particular case histories on curtain wall installations where the sealants have been used as superbonding mediums for building materials in use today. Proper handling, mixing, color availability, and methods of application are demonstrated. Also shown are varied applications, in both old and new structures, as used with sealing copings, expansion joints, tile and masonry. Data on various tests, including adhesion and stress, sag, low temperature, weather resistance and peel strength, are given. *Thiokol Chemical Corp.* L-12

Process Equipment. As indicated by the title, this booklet portrays process equipment. Included are descriptions of mixer drives; stirrers; agitators; portable mixers; horizontal, continuous and ribbon mixers; storage and mixing tanks; dryers; blenders; processing systems, vessels and kettles; ball and pebble, jet, rod and other mills; closed circuit grinding systems, and screens. An extensive use of photographs, schematic diagrams and tables aids in portraying related data on design, operation, capacities, sizes and other pertinent information. *Patterson Foundry and Machine Co.* L-13

Tank Weighing Systems. Equipment available for use with Emery load cells to form tank weighing installations is described in this 12-page bulletin. The systems, which provide for indication, recording, printing and controlling of the weight of the contents of tanks, are described fully, with details of construction and advantages listed. Schematic diagrams are used to show the construction and operation of the equipment. Various single-cell and multi-cell arrangements, many of which are applicable to bin-weighing systems, are also diagrammed. *A. H. Emery Co.* L-14

Sodium Benzoate. In addition to describing varied applications, including use in adhesives and coatings, this bulletin also lists the physical properties and available forms of U.S.P. and technical grades of sodium benzoate and benzoic acid. Sodium benzoate is highly soluble in water and is therefore easy to use from stock solutions. Under alkaline conditions, benzoic acid is more suitable as a preservative or chemical intermediate. *Hooker Chemical Corp.* L-15

Pine Oil Replacement. This 2-page information sheet contains a description of PX-1, a new pine oil replacement described as a proprietary combination of alcohols, hydrocarbons and surface-active chemicals. Applications and physical properties are also indicated. Applications include use in adhesives as an anti-foam and leveling agent. *Hodag Chemical Corp.* L-16

Concentrated Rubber Latex. Concentrated rubber latex made from natural rubber is the subject of an attractive 30-page booklet. Advantages of using latex in compounding are detailed, and properties are described. Recommended uses as adhesives are utilization for doubling textiles and for combining them to wood, cork or other materials, and as a bonding medium for unwoven fabrics. The latex can also be compounded into shoe cements, permanently tacky and self-sealing compounds, book and block binding adhesives and can sealing compounds. *Revertex Ltd.* L-17

V-S Drives. This 16-page, full-color booklet describes and illustrates how V-S drives operate and how they may be applied to various types of machinery in all industries. The manufacture and functions of the drive components, including regulators, exciters, motor-generator sets, operator's panels and motors are graphically covered. Condensed drive specifications, dimensions and accessories are also listed. *Reliance Electric & Engineering Co.* L-18

Micronizers. This 4-page bulletin discusses the potential in fine grinding offered by the Micronizer. It contains typical grinding information on a number of products, includes schematic drawings of the unit, and reveals steam and/or air requirements. It also points out how companies may take advantage of the manufacturer's fine grinding laboratory for custom or experimental grinding work. *Sturtevant Mill Co.* L-19

Corrugated Boxes. Aspects of unified merchandising, the value of display, the selection and use of color in corrugated packaging, and the part packaging can play in special promotions are covered in this 32-page booklet. Photographs of 30 individual "show packages" currently in use are reproduced, 17 of them in full color. The booklet also outlines points to consider in planning a merchandising package. *Hinde & Dauch.* L-20

Pyrojector. Photographs and engineering specifications fully explain the operation of the automatic heat, smoke and explosion relief unit known as the Pyrojector. These units open automatically when fire or explosion strikes, venting smoke, heat and explosive forces up through the roof instead of spreading them out across a building. These relief units are especially important in large, single-story buildings. *Swartwout Co.* L-21

FOR MORE INFORMATION on the trade literature reviewed here, use the Reader's Service Card elsewhere in this issue.

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shop talk

Company Changes

On November 15, 1958, The Bakelite Co., Division of Union Carbide Corp., becomes The Union Carbide Plastics Company.

Corn Products Company and Best Foods recently merged. It has just been announced that Corn Products Company has leased 5 floors in the building being constructed by the Corning Glass Works at 717 Fifth Avenue. The 5 floors constitute 63,000 square feet of space. Corn Products is moving from 17 Battery Place where it has been since 1912. The move uptown is expected to be made next summer.

Internationalism

There has recently been quite a bit of activity in the adhesives field abroad. Many American companies, of course, operate in Europe and in other markets of the world. On the other hand, we were somewhat surprised to learn recently that it is the European companies who are nudging the Americans to exploit these markets. There, too, in the foreign countries there is a reaching out for the universal adhesive—one that can be used on any number of materials.

There, too, there are some very strange situations abroad. Ireland, where much excellent paper is produced, did not have until very recently a bag manufacturing operation in the country. The paper was shipped over to England, made into bags and the bags sent back to Ireland. Surely, this is no way to help the Irish out of the very deep economic trough in which they continue to stagnate.

Autos have been assembled without bolts or rivets on the Continent. The methods have been dropped however—despite excellent development—because labor is cheap enough to allow older methods to compete!

We are running a foreign report for the first time in this issue. As these reports reach us from time to time, we will continue to run them.

Interesting Applications

The uses of adhesives are legion, and most cases completely utilitarian. From time to time, however, esthetic applications appear and these are rather heartening. In other cases the utilitarian makes possible the esthetic.

Universal Match Company of St. Louis, for instance, has recently introduced adhesive match books that adhere to cigarette packages.

Identification cards at a recent convention meeting lacked the usual pin which tears and tatters lapels. In its place was adhesive which held the tag on securely but removed easily without hurting the fabric. The adhesive material stood up well and could be used over and over again so that on leaving the meetings you could remove it and replace it on your return.

Rohm & Haas Company and Corning Glass Works jointly developed a protective covering for television picture tubes. The two companies claim that this makes it possible to eliminate the plastic tube covering that is standard on most television sets.

The accomplishment is the product of cleverness plus ingenuity plus imagination. It is a glass panel shaped to fit the tube surface and bonded with an acrylic resin. The covering method is still experimental but the two concerns say it should make possible new designs in TV sets, cut down reflections on picture tubes, giving wider angle of vision, and cut down on the possibility of tube implosion.

It has come to our notice that polyurethane, despite its magnificent qualities and applications, may not be a paying thing as yet. There seems to be some tight competition and a vacillation in its presentation. Could it be that it is not being presented in the best way? Could be.

Your editor attended the meeting of Committee D-14 of the ASTM in Washington on October 16th and 17th. It was a revelation. It is hard to find a group of men more dedicated, more serious, and harder working anywhere. Their achievements are something of which anyone would be proud. The work which goes on in the Subcommittees is a work the necessity of which cannot be over estimated.

Casein for Adhesives

Two new casein products for the adhesive, paint and paper manufacturing industries have been announced by the Borden Chemical Co., New York, N.Y. One is a water-soluble casein, called Protovac PV-424, designed especially for use as a latex stabilizer. It also can be used in grease-proof coatings, as an adhesive, and as a pigment dispersant and thickener in paints. Processors without "cooking" facilities can use the product because it can be prepared at room temperature with either a high-speed mixer or a slow-speed paddle-type mixer. The dry granular product has a low alkali requirement, is low foaming, and has high adhesive strength. The other product, Special 30-Mesh Argentine Casein, is suited for paper coating and other uses demanding a high-quality casein.

Spray Dried PVA

A spray dried polyvinyl acetate resin has been introduced by the Dewey and Almy Chemical Division, W. R. Grace & Co., Cambridge, Mass. The dehydrated emulsion, called Darex ESD, can be used in place of liquid vinyl emulsions wherever presence of water is undesirable. It is easily reconstituted by adding water and is expected to find wide use as an additive in dry mixes of specialty portland cement, as a vehicle for industrial paints, and as an adhesive base.

Enters Resin Field

National Polychemicals, Inc., Wilmington, Mass., has announced its intention to enter the adhesives field with the introduction of a line of specialty resins. According to Edward V. Osberg, president, the firm will shortly be marketing a line of phenolic and urea resins. Complete details as to specific resin types developed for the adhesives industry will be announced at a later date.

Highway Trailer Co. recently broke ground at Hazelton, Penna., for a $1,250,000 plant that it hopes to put into operation by the beginning of next year. The new facility will serve the Eastern Seaboard, producing truck trailers and a line of cargo containers. By next spring, the company hopes the Hazelton plant will be in full operation with a force of 450.